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*A DECADE OF NORTH AMERICAN PALEOBOTANY. 1890–1900.**

THE history of paleobotany constitutes a record of the most persistent and painstaking efforts to unravel a series of great facts which have been left by the wayside of time through an untold period of the earth's history, and to interpret them with reference to their true significance in the life of this planet.

Although attention had been directed to the phenomena of plants preserved in the crust of the earth essentially with the first discovery of coal, their occurrence did not excite very marked interest until the latter part of the seventeenth century—the observations of that time being made from the standpoint of the curious in nature, rather than from an appreciation or even suggestion of their scientific value, and it was not until 1709 that the first meritorious attempt to describe them in a scientific spirit was made. From then on through the remainder of the eighteenth century, a very considerable literature accumulated, and the infant science passed through what Ward has so very aptly called the 'twilight of its development,' while very nearly a full century passed before Schlotheim published the results of those studies which must be taken

* Address of the President of the Society of Plant Morphology and Physiology, given before the Baltimore Meeting, December, 1900.

as the real commencement of paleobotanical investigation. His work gains special prominence by reason of his having been the first to definitely and authoritatively deny the deluge theory and to assert that fossil plants represent the remains of an earlier vegetation, the originals of which are no longer to be found. But it was not until the time of Sternberg and Brongniart, of Lindley and Hutton, of Witham and of Göppert from two to three decades later, that interest in this line of research gained sufficient impetus to make its continuity assured. From that time on, progress has advanced at an accelerating rate, but the one fact which we need to keep clearly before us is that such progress as has been made in this branch of botanical science has been accomplished within the last seventy years. The activity thus referred to was chiefly confined to Europe, at least during the first half of the century, but it is of value to note that the great interest in such work, which centered there, in all probability had a well-defined influence upon the same line of studies in America—indeed, we may almost say a determining influence in promoting that spirit of enthusiasm for a subject then surrounded with the greatest difficulties, which has led to such noteworthy results. It is at least a fact of more than passing interest that the two earliest among the great paleobotanists of this continent—Dawson and Lesquereux—entered upon their work here just before the completion of the first half-century, and it seems not unlikely that while the one had imbibed a strong predilection for such studies from those eminent geologists with whom he had been associated while a student at Edinburgh, the other had gained inspiration not only from his scientific associates at Neuchatel, but also from the success of his earlier efforts as a botanist and his special studies of peat bogs for which he received the government medal, and through which also, he gained wide celebrity. It was, therefore, but natural that in returning to his native land to follow out the ideas so well established in Europe, Dr. Dawson should at once apply himself to the solution of the many problems which the rich deposits of fossil plants in the neighborhood of his own home at once suggested; and that Lesquereux, seeking in the United States an asylum from the political troubles which drove him and his colleagues from Switzerland, should at once continue there those studies which had already brought renown, and, in the rich deposits of Pennsylvania, Ohio and other States, endeavor to read the story of the ages as inscribed in the rocks of the Carboniferous formation. These facts are of significance in considering the progress of paleobotanical work on this side of the Atlantic, since Dawson and Lesquereux, the one in Canada and the other in the United States, were its most powerful exponents. Newberry was born and educated in the States, so that his activity in this direction was the result of purely local conditions. He, nevertheless, contributed most important results, chiefly in connection with public surveys, and his name stands with those of Dawson and Lesquereux as foremost among the paleobotanists of this continent. It is impossible to consider any progress in this subject, either now or in the immediate past, without reference to their work, since it stands as the foundation of that from which some of our most important deductions may be derived.

Lesquereux died on the 25th of October, 1889; Newberry died on the 7th of December, 1892, while Dawson died on the 19th of November, 1899, and thus within the short space of a decade there passed from our midst three of the most notable of the scientific men of this continent. I have felt it to be of special importance to give prominence to these names, since they stand

as the great link which binds the old to the new. As they commenced their work under conditions which are unknown to-day, they completed it with a full recognition of the different point of view which had been introduced by the wonderful progress of botanical science in recent years, and their final publications fell within the closing decade of the century. With the disappearance of these three men whose great activity accomplished so much, we now turn to the Smithsonian Institution and the United States Geological Survey, with their superb resources in material, appliances, and a well-trained staff of scientific men, as the real center of our future progress.

The somewhat peculiar conditions surrounding the study of fossil plants in the earlier days of the subject somewhat naturally led to its exploitation by geologists into whose hands it fell, and where it has very largely remained until the present day. There has thus arisen a somewhat prevalent idea that the study of fossil plants constitutes a science altogether apart from that of botany, and for this state of affairs the botanists are themselves chiefly to blame for not promptly claiming and cultivating a field peculiarly their own, for, as Ward well observes, "Botanists have, as a rule, ignored paleontology, while the paleontologists have gone on with their classifications in total disregard of the former." And he very appropriately adds that "The mutual dependence of these two branches of botanical science upon each other is so apparent that it is certainly a matter of surprise that it has received so little recognition by scientific men."

In whatever conditions this state of affairs may have had its origin, it is certainly gratifying to observe that botanists generally are more keenly appreciative of the valuable nature of the evidence which fossil plants may afford in solving questions of descent. It is also encouraging to discover that history does not fully sustain the extreme charge which has been brought against the botanical profession. Accepting Ward's list of twenty-two men from Scheuchzer to Carruthers, who may be considered to constitute the world's great leaders in paleobotanical research, it is to be noted that fifty per cent. were especially trained and exercised their profession as botanists—there being among the number those who have produced a strong impress upon the general history of the science, and it will well repay us to briefly glance at some of their achievements.

In 1820 Sternberg commenced the issue of his well-known *Flora der Vorwelt*, the publication of which extended over a period of eighteen years. This important work, together with the succeeding works of Brongniart, Göppert and Corda, opened the way for the final reception of the idea of evolution in plants.

To Adolph T. Brongniart, a contemporary of Sternberg's, must be ascribed the greatest measure of influence exerted upon the development of paleobotany during the first three decades of the century,—a fact so eminently true that he is commonly spoken of as the real founder of the science. His observations upon the formation of pollen grains in the mother cells of *Cobæa*, and the frequency of occurrence of the pollen tube, were the first to direct attention to this new line of inquiry. In 1843 he devised and published a system of classification which not only maintained a strong hold in France for many years, but it gained many adherents throughout Europe. In his work on fossil plants we gain, for the first time, a definite indication of that succession in the development of plant life through the various geological formations, which constitutes so important a feature of modern botanical science.

Göppert was the first to draw attention

to a rise in temperature during the process of germination, and his works on fossil plants are too extensive and well known to require special consideration at this time; but in the prosecution of his studies, he strongly emphasized the necessity of treating all such remains from a strictly botanical point of view, and he was especially prominent in giving great weight to characters derived from a study of the internal structure, thus recognizing the school already founded by Witham in England.

Corda was already well known for his valuable work on the fungi and mosses, before entering upon those paleobotanical studies through which his name more commonly appears.

The great number and value of Unger's contributions to botanical science lent special weight to his conclusions respecting fossil plants. In 1837 he described the spermatoids in various mosses and declared them to be the male elements of fertilization. In 1855 he first directed attention to the great resemblance between the protoplasm of the plant cell and the sarcode of the more simple animals,—a discovery which was later brought into great prominence and finally led to the conclusion that protoplasm is the foundation of all organic development. He was the first to successfully oppose Schleiden's theory of free cell formation as applied to the growing apex of stems, and to show that such cells arise by division—having their origin in a meristem. His work, in conjunction with that of von Mohl, Nägeli, Braun and Hofmeister, laid the foundation for a true conception of cell formation. In his 'Anatomie und Physiologie der Pflanzen' he introduced many new and valuable ideas respecting the character of the protoplasm, and gave a concise idea of the cell in its various complexes as families, tissues and fusions. With von Mohl's text-book, this work accomplished more than any other in disseminating a knowledge of the subject up to 1860. In 1850 he issued the first complete manual of fossil plants, giving a systematic account of 2,421 species.

C. F. Schimper founded the theory of phyllotaxis. He first contributed to the study of fossil plants in 1840, and his 'Traité de paléontologie végétale' constitutes the most important of all the works on fossil botany as presenting a complete manual of the subject in accordance with the then current ideas of botanical science.

Williamson has contributed to the advance of paleobotanical knowledge in so many important ways, especially during his later years in conjunction with Carruthers, that a preliminary statement of progress would be wholly incomplete without reference to his work. His earliest experiences were gained in making the illustrations for 'Lindley and Hutton's Fossil Flora of Great Britain in 1837.' Since then his time was largely devoted to independent research in the same field, with a success which is well known, and his studies of the carboniferous flora of Great Britain have resulted in most important contributions to our knowledge of those early types of vegetation. This is especially true with respect to the Calamarieae, Lepidodendreae, Sphenophylleae, the ferns and Lyginodendron. In the case of the first two, more particularly, he laid the foundation for all our subsequent knowledge respecting them. He furthermore showed that in Lyginodendron the fructification places this group of plants beyond question among the archegoniates, but that like recent Gymnosperms, they possess a secondary wood growth from a cambium layer. In establishing this fact he came into direct contact with the views of Brongniart, who held the formation of the wood from a cambium layer to be an absolute criterion of the phanerogams. From Heterangium and Lyginodendron he reconstructed a type of plant which he de-

scribed as having characters intermediate between those of the ferns and the Gymnosperms, and he thus opened the way for the final recognition of the Cycadofilices by Potonié, to which also such hitherto doubtful types as Medullosa and Myelopteris undoubtedly belong—a group of plants the recognition of which has gone far toward clearing up most important questions relating to the phylogeny of the Gymnosperms, and of the Cycads in particular.

It will thus be seen that to a large extent at least the study of fossil plants has proceeded on lines parallel with those in other branches of botanical science, and that the growth of the subject has substantially been directed by men eminent as botanists. Originally employed as a distinctive term for a subject supposedly outside of botanical science, paleobotany has more recently come to have equal rank with other divisions of the science such as histology, physiology, ecology, etc. Such artificial distinctions as formerly existed are fast disappearing, and we are now rapidly approaching, if we have not already entered upon, the first stages in the realization of that harmony between the botany of recent and extinct forms, the accomplishment of which Ward in 1885 recognized as so eminently desirable, but considered so difficult of attainment.

One of the earliest views attaching to the relations of paleobotany and geology was that of the supposed value of fossil plants in determining the age of deposits, and this found expression in the idea that the sequence with which plants were known to occur must be correlated with the succession of geological formations in such a way that the age of the latter could be ascertained by an examination of the flora. Although fundamentally correct, the precise application of the principle was found to lead to such erroneous conclusions that geologists soon came to look upon the evidence of fossil plants as untrustworthy, and it is only within recent years that there has been any material alteration in this point of view. So long ago as 1871, however, we find Sir William Dawson, who possessed a deeper insight into the bearings of evidence derived from fossil plants than was the case with the majority of geologists, expressing the opinion that "fossil plants have hitherto been regarded as of much less importance than fossil animals in determining the age of rocks, and in some portions of the geological series, where formations are strictly marine, their value is, no doubt, quite subordinate. But there are portions of the geological formations * * * in which their value becomes much greater"; and in 1892 we find him giving a more pronounced expression of opinion when he says that "The history of geological discovery in the Canadian Northwest affords a convincing proof of the value of fossil plants when carefully collected, * * * in determining the geological ages of the formations in which they occur, while there can be no question of their paramount value in indicating geographical and climatal conditions."

In 1882, Ward laid down in a definite and authoritative manner, the principles of geological correlation by means of fossil plants. He clearly showed that the old idea of contemporaneous deposits with identical fossils, as originally stated with so much prominence by Schimper and others, is entirely erroneous, and that it is relative contemporaneity or correspondence of succession which must be considered, an idea which the late Sir William Dawson often laid great stress upon in the course of his discussions with the writer. In order to give proper expression to the idea of correspondence of succession, Ward has proposed and for several years has employed the appropriate term 'homotaxis.' He lays down the general principles that

1. Great types of vegetation are characteristic of the great epochs in geology, and it is impossible for types of one epoch to occur in another.

2. Given a sufficient body of facts—*i. e.*, a suitable series of specimens—it is possible to determine as conclusively for nearly related deposits as for those more widely separated.

3. It is of the highest importance that plants should be correctly determined.

At the same time White, who deplores the 'surprising and painful inadequacy of materials relating to stratigraphic paleobotany,' shows that the present temporary obstacles to accuracy in correlation are to be found in

1. The wide vertical range of identical species.

2. The lack of standard paleobotanic sections, *i. e.*, a knowledge of plants strictly limited to various beds.

These principles form the basis of methods which have been used for the last eight years, and are employed with great success by members of the United States Geological Survey in determining the ages of deposits. This practise finds one of its latest and best expressions in a paper by Mr. David White on the 'Relative Ages of the Kanawha and Allegheny Series.' On account of similarity in the material composing it, the similar position of the series as a whole in the general lithological sequence, and the fact that the Allegheny series has been traced stratigraphically with great detail as far as central West Virginia, the Kanawha series has long been regarded as *in toto* the exact, though greatly expanded, equivalent of the Allegheny series. Following out the methods formulated by Ward, White has conclusively shown that this view is not a tenable one, but that as indicated by the testimony of the fossil plants, only the upper half of the Kanawha series can be correlated with the lower portion of the Allegheny series, in each of which identical forms of plants occur; whence it appears that the two series overlap in such a manner that the Allegheny is in direct chronological succession in the lower Kanawha.

The occurrence of plant remains in the coal measures, which were in their general features comparable with existing types in the tropics, led Schlotheim to regard fossil plants as having a direct value in determining the nature of the climatic conditions under which they flourished. This idea was later taken up by Brongniart, who amplified it, and from the various types of vegetation known by their fossil remains, determined what he conceived to be the climatic conditions of the great geological periods, corresponding to the great changes in plant types. The views thus adopted have been accepted in principle by all succeeding authorities and constitute our guide post to day. Writing in 1879, the late Asa Gray felt no hesitation in laying down the general rule that "Plants are the thermometers of the ages, by which climatic extremes and climates in general through long periods are best measured," and in this connection he also pointed out that "Even very moderate changes either one way or the other, in temperature, would have excluded either the vine or the date palm which for at least five or six thousand years, have grown in proximity and furnished food to the inhabitants of the warmer shores of the Mediterranean." Three years later, in the course of extending his important studies relative to the Erian and Upper Silurian formations, Sir William Dawson laid down the general rule that "When we can obtain definite information as to the successive floras of any region, we thereby learn much as to climate and vicissitudes in regard to the extent of land and water," and that with reference to such points, "The evidence of fossil

plants, when properly studied, is, from the close relation of plants to their stations and climates, even more valuable than that of animals." But he very appropriately adds the caution that "In pursuing such inquiries, we should have some definite views as to the nature and permanence of specific forms, whether with reference to a single geological period or to successive periods."

Balfour had already pointed out the necessity for a wide acquaintance with plant distribution in order to apply fossil plants with any success as tests of climate, and Renault in 1881, expressed views similar to those held by Dawson, when he pointed out that plants were superior to animals as a test of climate because of their relative fixity, and therefore more permanent relations to their environing conditions—the ability to migrate rendering animals an uncertain guide.

While their relative fixity is an element which imparts a special value to plants in this respect, it must nevertheless be recognized that influences such as long rivers with a northerly and southerly course, are likely to introduce a disturbing element by reason of their causing a mingling of the floras of dissimilar climates, and for this and other reasons it is generally conceded that drift material must be carefully excluded from all considerations which involve questions of climate.

Variations in the soil, exposure to light, humidity of the atmosphere and many other conditions which tend to promote structural and functional modifications, and eventually also type alterations, must be carefully weighed and that these elements have been as important factors in the past, as they are at the present day, cannot be doubted when we recall the profound modifications exhibited by the various floras of Paleozoic time, and the fact, to which Lesquereux has directed attention, that "A single modification of the character of the vegetation generally follows great geological disturbances which produce permanent changes in the atmospheric condition of a country."

In 1872 Saporta pointed to the determining influence of atmospheric conditions, and showed that the relative preponderance of the monocotyledons and dicotyledons could be referred to conditions of humidity in such a way that the former increase while the latter decrease when the humidity becomes general, or with a diminution of temperature; and that, in consequence, a dry and warm climate favors a larger proportion of dicotyledons than a warm and moist, or a cold and moist climate. With these considerations in mind, we cannot avoid the conviction that the modern science of ecology as expounded by Warming and Schimper, and as exploited on this side of the Atlantic by Ganong and others, must throw much light upon questions of this kind by giving accurate data upon which to base comparative studies.

The peculiar conditions under which plants pass into the fossil state render it an altogether exceptional circumstance to find all parts present. This is more particularly true of those more delicate tissues and organs which constitute the structure of the gametophyte, but it also applies with considerable force to all the soft parts of the sporophyte. Important exceptions to this rule nevertheless appear. Renault has already shown that in Cordaianthus, the microspores are to be seen in position within the canal of the archegonium, as also in the pollen chamber, and they exhibit very clearly the development of the prothallus. He has also observed similar conditions of preservation in various Calamarieae. More recent investigations have also given another important example of this kind in *Parka decipiens*, the remains of which show prothalli and both kinds of spores, and, coming as it does from the Devonian, it

probably stands as the most ancient representative of the heterosporous filicineæ we know. Other less conspicuous cases might also be cited, but the general fact that it is only the more resisting structures, such as those of the stem and leaves, which are recognizable, has led to attaching great importance to the anatomy of the wood. This was first pointed out by Witham, who has since been followed by many of the leading paleobotanists of Europe, and to some extent by those of America. On this side of the Atlantic, the idea was first taken up by the late Sir William Dawson in 1845, and since that time its application has been made more prominent through the work of Knowlton and others.

As a special indication of climate, the presence of growth rings—from the time of Witham who considered the absence of such structural features to be evidence of a tropical climate—has been regarded as one of the important factors in this respect. The history of the subject shows a great divergence of opinion as to the origin of these structures, but the general position may no doubt be correctly taken, that growth rings are largely dependent upon, and are therefore expressive of alternating periods of growth and rest. Such periodicity in functional activity bears a more or less close relation, among other things, to seasonal change in such a way that, other things being equal, the more definite the changes from summer to winter, the more pronounced will the growth rings become, and the more definite will be their correspondence with age. That this holds true only within certain limits is well known. Thus many Chenopodiaceous plants make several growth rings within one season independently of latitude, and the red maple, within the latitude of New York State, has been known to make twelve growth rings within a period of eight years. Fernow has recently drawn attention to the fallacy of many of the opinions respecting the value of growth rings as an index of age, and the correctness of the views which hold them to be of importance in this respect, and he points out that under ordinary circumstances in temperate latitudes the ages of trees may be correctly ascertained within a limit of one-half to one year of error. Tropical trees generally exhibit an absence of growth rings, but exceptions to this rule are not unknown. It would therefore appear that while much caution must be exercised in applying such a test to the case of fossil plants, when used with a due recognition of its limitations, the test of growth rings as evidence of climate becomes a valuable aid.

One of the most common methods of identifying fossil plants has been through their leaves. This has of necessity resulted from the fact that these organs are much better adapted to preservation than most other parts of the plant, and that they therefore constitute the most accessible of all plant remains. The work of Lesquereux and Newberry rests very largely, indeed almost exclusively, upon evidence of this sort, and the venation has been made the basis of both generic and specific distinctions. Leaves, however, offer an unreliable basis when taken alone, and this results from the fact that the venation is not of specific rank, and often fails also in generic significance, while the form of the leaf may present so many changes within the limits of the species that no great dependence can be placed upon it. This is notably the case in such genera as *Liriodendron*, *Sassafras* and *Platanus*, and it is only necessary to refer to the comparative studies by Ward, on the 'Paleontologic History of the Genus *Platanus*,' and to the observations of Holm on Liriodendron, to give emphasis to facts long known to botanists, and show what erroneous and extremely misleading results may readily follow from the study of fossil

leaves, even when they are presented in a complete condition—a difficulty which is enormously increased when the fossil happens to be fragmentary, as is generally the case. The errors arising from a disregard of such facts, have led to no end of confusion, and have been among the most prolific causes of extensive revisions. It is therefore clear that for botanical purposes such fragments have a very limited value, but as Ward very correctly observes, for geological purposes it is not so much a question of correct botanical determination as the correct recognition of a plant once named and associated with a given deposit. With these limitations before us, we can form a more correct estimate of some of the recent conclusions bearing upon the climatology of former geological times.

The great analogy of climatic conditions recognized as existing between those which influenced the flora of the Dakota Group and those which now govern the vegetation of the North American continent, led Lesquereux to the conclusion that the flora of North America is not at the present epoch, and has not been in past geological times, composed of foreign elements brought to this continent by migration, but that it is indigenous. Its types are native, and the diversity of their representatives has been produced by physical influences. All the plants of the American Cenomanian, except those of *Ficus* and the *Cycads*, might find a congenial climate in the United States between latitudes 30° and 40°.

An examination of the Tertiary flora of the Yellowstone has shown that the present flora of the Park has comparatively little relation to it and cannot be regarded as a descendant of it. Knowlton concludes that the former had its origin to the south, while the latter had its origin to the north, and that the climate prevailing in Tertiary times was, therefore, quite different from that now known, and in all probability not unlike that of Virginia of to-day.

A study of the Lower Carboniferous Measures of Missouri has led Mr. David White to draw attention to the uniformity of climate which prevailed over Europe, within the Arctic Circle, in North America, Asia and, to some extent at least, in the southern hemisphere during Carboniferous times, and the probability that the extremely close relationship between the floras of the Culm, Millstone Grit and basal portions of the Lower Coal Measures in Europe and America point to wonderful facilities for plant distribution during Culm and early Mesocarboniferous time, facilities which, with the aid of an even climate, made possible the comparatively regular distribution and sequential order of probably nineteen-twentieths of the genera, and an unknown proportion of the identical species; and he is disposed to consider that the conditions favorable to plant distribution, and consequent comparatively homogeneous dispersion of the successive floras of the Northern Hemisphere during the period extending from the later Culm to near the middle of the Mesocarboniferous, have never been equalled since. That there was plant migration cannot for a moment be doubted. Yet the evidence of distribution, of vertical range, of characteristic associations, and of the succession of the floras, indicate such geographical uniformity of climate and such facility of intermigration over a minimum distance, as to justify us in regarding the astonishingly similar associations of identical or closely related genera and species which characterize each stage, zone or group of the Culm and Mesocarboniferous, as essentially contemporaneous in all the basins of the Northern Hemisphere. From this evidence he draws the final inference that many of the species or genera of the Mesocarboniferous were, under local conditions, evolved

in different portions of the land surface, whence they spread with a rapidity difficult to conceive at the present day, over the greater portion of the northern continents.

An extended study of the Pottsville series of West Virginia offers an important illustration of the rapid differentiation of, and change in, floras during this period. White shows that "The period of change in conditions of environment attending transition from Lower Carboniferous marine to true Coal Measures formation, was marked by an extraordinarily rapid development and modification of plant species. Within a relatively short period the meager flora of the Devonian and Pocono is multiplied to the inexhaustively fecund and highly diversified flora of the Carboniferous, a development scarcely possible except in this division of organic life (plants), which is the most sensitive to climatic change or environment, excepting, perhaps, the higher vertebrates. In the lower part of the Pottsville series many species show a relation to the floras of the Vespertine or Calciferous Sandstone series; in the middle portion many of the forms are unique, while in thickly developed sections it is only near the top of the series that we see occasional Coal Measures forms creeping in."

Recent investigations, by the Committee of the British Association charged with an investigation of the Pleistocene deposits in the vicinity of Toronto, have brought out in a very convincing manner the fact that three distinct climatic periods may be recognized. During the first the vegetation and the climate were comparable with those now found in Labrador and the more northern portions of the Province of Quebec. This was followed by a period during which more southern types of vegetation were introduced, and the climate was probably comparable with that now common to the Middle United States. A third wave drove these plants southward again, and once more northern types of vegetation were introduced, but not quite so boreal in their character as the first, and these conditions have remained unchanged in the present day.

From the considerations which have thus been passed rapidly in review, it would appear that the advantage which such studies offer to the botanist is not very large, and that while the value of paleobotany to the geologist may, upon these grounds, be conceded to be great, the solution of questions bearing upon climate and geological succession can only be regarded as of a secondary importance from a botanist's point of view. The great problems which confront the botanist of to-day relate to the filling in of those gaps in plant descent which become apparent from a study of existing species. He is, therefore, called upon to complete, as fully as possible, our knowledge of that sequence in development which is at present justified, not only on theoretical grounds, but also on the basis of observed facts. To this end all other branches of the subject are subordinate, and since paleobotany has already contributed in so many important ways to enlarge our knowledge in this direction, it is my purpose to ascertain how far the progress of the subject in America, during the last decade, has proved of real assistance, the directions in which aid may be looked for, and the limitations within which useful results may be expected.

Our conception of the four great primary divisions of the plant world and of their subordinate branches is based upon the theory of succession in development, but our knowledge in this respect is far from complete, and here and there gaps occur in places where, on theoretical grounds, there should be perfect continuity in development. This defect arises from several causes.

The recognized law that the history of the individual more or less fully repeats the

history of the species, at once points to the superior importance of embryological data as the real link through which primitive forms may be united; but as we approach these primitive forms it is to be observed that the differentiation of types becomes less and less clearly defined until they merge in the ancestral form, and this must hold true of extinct types as well as of those now existing. While on the one hand such approximations may greatly aid in the solution of given problems, on the other they serve to defeat this end by reason of the difficulty experienced in their recognition and in a demarcation of their precise limitations.

In the progress of development many of the more primitive types of life have disappeared, while those of advanced organization have survived, and thus many of the gaps revealed by the study of existing species are of a more or less permanent character, and can only be bridged hypothetically. It is in emergencies of this kind that we instinctively turn to geological records, and in paleobotany seek the only available means of solving the difficulty. But here again, the complete obliteration of perishable materjal in the process of petrifaction, the breaking-up of the original body into widely separated fragments which can be correlated, if at all, only after the most prolonged and arduous labor, and the difficulty of recovering plant remains, even though they may be present in the rocks, constitute obstacles to the progress of knowledge in this direction, of the most formidable character. Hence from a botanical point of view, our knowledge is extremely imperfect; but when we take into consideration the serious nature of the difficulties involved, the substantial progress which has been made during the last seventy years, and more particularly during the last two decades, affords ground for much satisfaction.

In this connection we may note the somewhat suggestive observations of White to the effect that "The rapid development and series of changes or modifications, presented by the plants of the Pottsville Series of both Pennsylvania and West Virginia, point to the possibility that in this series we may eventually discover facts of the deepest significance relative to descent, but the present fragmentary nature of the material recovered, which consists altogether of portions of foliage, will not warrant final conclusions in this direction."

The relative sequence of the Pteridophytes and Spermatophytes, as also of the Gymnosperms and Angiosperms, the Monocotyledons and Dicotyledons as exhibited in geological succession, is substantially the same as that derived from the study of living forms. But with reference to their points of contact and the relations of the more subordinate divisions of these groups, especially with reference to the Thallophytes and Bryophytes, the evidence of geological records often proves altogether inadequate and conveys no very exact idea of the real phylogeny. As living plants constantly approximate to the ancestral type as we descend in the scale, so likewise a similar approximation must be exhibited in earlier geological time, and this slight differentiation of primitive forms, which are very imperfectly known to us through mere fragments of the original plants, is one of the most prolific sources of error in paleobotany, and has resulted in the constant shifting of plants from one position to another.

On theoretical grounds the Thallophytes must have flourished in the very earliest periods of the earth's history, and their remains should occur in rocks of the Laurentian age, but if we leave out of consideration those very problematical forms which have sometimes been held to represent plants from the early paleozoic, nothing recognizable appears until the Silurian, in

the later portions of which we are abruptly confronted with algæ of gigantic dimensions and a high degree of organization, thereby implying the existence of a long line of ancestors in the earlier geological periods, of which all traces seem to have disappeared. Passing into the Devonian, such types gain greater prominence in point of numbers, and thence on to the present the successive formations give evidence of the continuous development of this type of plant life; and while in Nematophycus, Chondrites, Lagynophora and Bacillus we find well-developed representatives of types known at the present time, their ancestral forms are to be sought in the Laurentian and portions of the early Paleozoic, where the only evidence of their former existence is to be found in the abundance of graphite and other forms of carbon. The most perishable of all plants, the Thallophytes, readily yield to that decay which is the invariable antecedent of petrifaction, and the slight residue of structure which might remain is commonly obliterated in the further metamorphosis of the rocks in which they are held. It is therefore altogether exceptional that such plants should be preserved in recognizable form, and their value for phylogenetic purposes, although very limited, acquires an unusual interest and importance. This is eminently true of the very plants through which the line of direct descent passes, since the green algæ are, of all the group, among the most perishable. For these reasons it is in no way surprising that additional representatives of the Thallophytes among fossil plants are rare, that such plants as are found add but little to our knowledge of descent, and that they fail completely to illumine the line directly ancestral to the Bryophytes—the evidence so far accumulated bearing altogether upon side lines represented by relatively durable remains.

Among the higher Thallophytes, a few additions have been made to the Charophyceae by the recognition of the characteristic fruits in the Lower Tertiary of Wales, Ohio, where two species—*C. Stantoni* and *C. compressa* of Knowlton are found. Fruit-like bodies having the external characteristics of *Chara* have also been observed in the Devonian at the falls of the Ohio, thus giving to this group of plants the possibility of a very ancient lineage which is justified on theoretical grounds. The very fragmentary remains so far known, the preservation of which depends upon their calcareous investment, nevertheless serve to throw no additional light upon previous knowledge. Migula has suggested that these plants occupy a position superior to the Thallophytes as a whole and coordinate with the other great divisions of the plant world. This view has been adopted by Seward in his most recent contribution to paleobotany, and Campbell also regards it as deserving recognition. To the solution of this question, however, the fossil representatives contribute no information not derivable from existing species.

Among the Phaeophyceae considerable interest has attached for a number of years, to a remarkable fossil originally described by Dawson as Prototaxites under the impression that it represented a primitive Gymnosperm allied to the Taxaceae. This view was disputed by Carruthers, who was the first to determine the algoid nature of the organism, and he assigned to it the name *Nematophycus*. Subsequent investigations of North American material amply justified this view, and Dawson was led to so far modify his original opinion as to employ the name *Nematophyton*. Several provisional species from the Silurian and Devonian of America have been recorded, and to these there have been added three species from the same formations in Europe. Carruthers has been led to suggest a possible

relationship to the modern Siphoneae, but an extended study of American forms leads to hesitation in giving this opinion unqualified acceptance. Several years since, the belief was expressed that there were grounds for supposing a relationship with Laminarieae, and the genus *Lessonia* was cited as likely to afford the best means of comparison, but the impossibility of securing suitable material caused such studies to be deferred. Recent studies by MacMillan have given us a detailed account of the morphology of this extremely interesting but not readily accessible plant, and from material which he has kindly supplied the writer, it is to be noted that very striking points of resemblance to *Nematophycus* appear. Without entering into details on the present occasion, it may suffice to indicate that similar growth layers, the presence of a distinct cortical structure, the general disposition of the elements as seen in transverse section, and the presence of radial spaces, occupied by elements of the medulla which there assume a horizontal position and develop special relations to one another, are all features which point with considerable force to possible relationship. Beyond these facts, however, our present knowledge respecting the phylogeny of this group of plants will not permit us to go.

The Bryophytes constitute another group which, from their delicate organization, are not likely to be found either in very considerable numbers or in a very perfect state of preservation as fossils. They nevertheless occupy a most important position in plant evolution, since they are considered to constitute the connecting link between the green algæ and the higher vascular plants, their derivation from the former being through the thalloid liverworts, while their algoid ancestry also appears in the filamentous protonema of the true mosses and in the motile spermatozoids of the entire group. From the phylogenetic position of these plants as determined by a study of existing forms, we are led to infer that they must have had their origin in very early geological times—antedating the more fully organized terrestrial forms of which they are to be considered the ancestors. There is thus good reason for supposing them to have flourished as early as Devonian or even Silurian time, but the evidence derivable from the rocks shows no recognizable remains of these plants until we reach the later Mesozoic, while it is not until Tertiary time that they become clearly defined. It is, therefore, reasonably certain that the solution of questions relating to the origin of this group must rest altogether upon evidence derived from a study of existing species—to such, fossil botany has as yet contributed nothing.

From their more durable structure, which offers a higher degree of resistance to the operation of decay, the vascular plants have always been found in the best state (sometimes remarkably perfect) of preservation, and they have therefore always presented the best of opportunities for phylogenetic studies, more especially in consequence of the great abundance of their remains and the increased probability of deriving data of permanent value from them. In considering the distribution of these plants in geological time, one is impressed not so much with their often extensive vertical range, as with the abruptness with which special types appear through representatives of a high degree of organization. This has already been noted in the case of the Thallophytes, and among the vascular plants it is no less remarkable. The ferns which first appear in the Devonian are represented not only by foliage and fruit, but also by stems of large dimensions; the *Cycads* abruptly appear in the Jurassic and Cretaceous while the Angiosperms as suddenly appear in the Mesozoic, where they gain great prominence in the Cretaceous formation.

From these and other similar examples we are justified in the inference that such highly organized types represent the culmination of lines of ancestors which must have extended far back into the earlier geological periods, a view which gains weight from recent researches.

Among the ferns the Eusporangiateae are recognized as representing the primitive forms, and they constitute the starting point for two parallel lines of descent, one of which leads to the Leptosporangiateae and finally culminates in the Heterosporeae. Recent studies of *Parka decipiens* have shown that this hitherto problematical organism from the Devonian is unquestionably to be regarded as one of the heterosporous felicineæ, possibly allied to Marsilia. The occurrence of this plant in the same horizon as that in which the Eusporangiateae first appear, somewhat abundantly and in a high state of development, is of great significance, since it points without question to the origin of the ferns at a very much earlier date, probably not later than Silurian time.

In studying a new Taeniopterid fern from the Lower Coal Measures of the Carboniferous of Henry county, Missouri, Mr. D. White notes certain resemblances on the one hand to *Alethopteris*, and on the other to *Taeniopteris*, to which he assigns his plant under the name of *T. missouriensis*. Discussing this plant in relation to other known forms of the Marattiaceae, he endeavors to construct a hypothetical relationship which shows a *Megalopteris* stock of the Lower Devonian, to give rise in the Middle Devonian to *Neuropteris*, *Alethopteris* and *Megalopteris* proper. Thence through successive formations these three lines of descent lead to *Dictyopteris* and *Odontopteris*, which culminate in the Permo-Carboniferous, and to *Danaeopteris*, *Lomatopteris*, *Oleandridium*, *Taeniopteris*, etc., which either culminate or have their origin in the Trias, while *Angiopteris* originates at this latter horizon and *Danaea* makes its first appearance in the Jurassic. The hypothesis is a suggestive one, but as the fructification of these plants is wholly unknown, and as we have no data derived from the internal structure, while the relations exhibited are based entirely upon leaf characters, it is impossible to attach very great weight to it except as a possible starting point for further observations.

Recent studies of modern Equisetaceae and the various species of Calamites by Jeffrey, offer some very suggestive conclusions respecting the phylogeny of this most interesting group of plants now in the later stages of decline. Embryological studies show that similar structures in the prothalli, the absence of a basal cell from the archegonia and the epibasal origin of both root and shoot, serve to establish a definite connection between the Equisetaceae and the Homosporous Lycopods, a relation which is further justified by a comparison of the stem structure. He also shows that the close agreement between the Equisetaceae and the Sphenophyllaceae makes the latter the protostelic ancestors of the former. An acceptance of these conclusions would carry our knowledge of the phylum back to Lower Devonian time, and show that while the direct line of descent passes through the Sphenophyllaceae and Equisetaceae, the Calamites arose as a side line.

The phylogeny of the Gymnosperms has for many years constituted a subject of the foremost importance and interest, and it has received the most careful consideration at the hands of both paleontologists and botanists. The deep interest which centered so largely in the Cycadaceae, has within the last few years received additional strength not only through the discovery of those remarkable collections of *Cycads* from the Mesozoic, which Ward

has already described on the basis of their external characters, and which Wieland is now engaged in studying from the standpoint of their internal structure; but also from the very noteworthy observations of Weber and Hirase respecting the occurrence of motile spermatozoids in Zamia and Ginkgo. Our knowledge of the North American *Cycads* adds nothing as yet to the phylogeny of these plants as determined by European investigators, but the progress of the studies of the Yale material will be watched with the greatest interest, in the hope that they may yield facts of importance in this connection. In the meantime, however, the deep significance of conclusions derived from the study of European material justifies a brief reference to the position of our present knowledge of this group of plants, which may be said to have commenced with a recognition of the similar characteristics possessed by a small group represented by Noeggerathia, Medullosa, etc., characters which pointed both to a filicinean and cycadean connection, but which were too poorly defined to permit the assignment of the representatives to any specific position. A recognition of the identity of Medullosa and Myeloxylon as suggested by Solms-Laubach and later confirmed by Schenck and Weber, served to prepare the way for a clearer conception of the relations existing between the individual members as also with other groups, and this gained final expression in Potonié's determination that Noeggerathia, Medullosa, Lyginodendron, Heterangium, Cladoxylon and Protopitys represent a distinct group of plants having an affinity with the ferns on the one hand, and with the cycads on the other, thereby becoming of ordinal value. He therefore established the name Cycadofilices as a proper recognition of the important position occupied by them. An additional contribution to our knowledge of this exceptionally interesting group of plants has been given by D. H. Scott in a study of Medullosa anglica, which he shows to have a probable filicinean connection through the Heterangium type. He further concludes that while the Medulloseae are to be considered as having affinities with the Cycadaceae in a broad sense, they really constitute a short, divergent branch of the phylogenetic tree.

The ancestry of the Coniferæ has excited an interest almost as profound as that centering in the *Cycads*, and although we are enabled to trace these plants more or less fully back to Silurian time, we are as yet unable to establish their relation to an inferior group, as in the case of the *Cycads*. Our present knowledge of the descent of the Coniferæ rests chiefly upon a recognition of that line of ancestry which passes through Cordaites and culminates in the Araucarian type. This has been gained by a careful study of the structure of the wood, as also of the foliage, inflorescence and fruit, as obtained from numerous European localities, notably those in France. Extensive collections of North American Cordaitæ are represented by the wood and foliage only, and though their value for phylogenetic purposes is thereby relatively limited, they have nevertheless contributed important data derived from a study of the stem structure, and afford a striking illustration of the superior importance of those histological methods first employed in such connection by Witham, the value of which was so strongly insisted upon by Brongniart. Apart from the general evidence derived from this material, which points with great force to the development of the Araucarian type, the structure of the stem is frequently preserved with such perfection as to permit recognition of important phases in the evolution of structural features. As long ago as 1840, Don pointed out that in the tracheids of *Cycas revoluta*, scalariform structure may occur at one end and bordered pits at

the other. In 1869 Williamson was able to point to similar structural modifications in *Dadoxylon*, and to show that regularly transitional forms gave proof of the derivation of the bordered pits from scalariform structure. Recent studies of North American Cordaitæ have given conspicuous examples of the same kind, and show that a continuous series of radial sections will display regularly transitional forms—often combined in the same tracheid—passing from the spiral vessels of the protoxylem through scalariform vessels, thence into tracheids with transversely elongated bordered pits, which successively become shortened up until there is developed the typical, multiseriate, hexagonal and compactly crowded bordered pit so well defined not only in the Cordaitæ, but also in the modern Araucarieæ. These facts possess the deepest significance from a phylogenetic point of view, since they afford an additional and reliable indication of derivation, and in the present connection, they serve to point with considerable force to the idea that among modern Conifera, the widely-separated bordered pit which in many instances wholly disappears is for that line of descent the culminating form of this type of structure; while in the Angiosperms the modification has been carried to a greater extreme and involves the reduction of the pit to the form of a simple slit or pore, and ultimately to its complete obliteration as a final expression of the secondary growth of the cell wall. Structural alterations of this nature involve also a more or less profound influence upon functional activity as expressed in the distribution of nutrient material.

I have thus endeavored, within the limits of the time at my disposal, to briefly indicate some of the more prominent directions in which paleobotanical activities have developed in North America within the last decade. While this review shows that some substantial progress has been made, that much has been accomplished in the direction of laying the foundation for future studies, and that the study of fossil plants is gaining greater prominence as a necessary aid to our knowledge of plant descent, it also brings into relief the fact that progress in this latter direction must of necessity be slow, and the result of laborious methods of investigation extending over such long periods of time as will permit the accumulation of great stores of material, and the careful piecing together of fragments which separately have little or no significance. Nevertheless the rapid progress which has marked our knowledge of fossil plants during the last twenty years, and the acceleration of this progress within the last two decades, together with a greater appreciation of the fundamental importance of such studies in questions of relationship, afford much ground for regarding the future of paleobotany on this side of the Atlantic as one of promise.

D. P. Penhallow.

McGill University.

Determination of the Sun's Distance from Observations of Eros.

The tendency of the time toward thorough organization and cooperation in large enterprises is well illustrated in modern astronomy. Twenty-five years ago, a dozen leading observatories, by mutual agreement, divided the northern sky into zones in such a way that their meridian circle observations would combine to form the excellent Astronomische Gesellschaft star catalogues; and this great work is now nearing completion. The work of charting the sky by means of photography was similarly organized by the Astrographic Conference in Paris some ten years ago.

About fifty of the principal observatories of the world are now cooperating in a great program of observation for improving our

knowledge of the distance between the earth and sun. Fully half the resources of the Lick Observatory, the Lick Astronomical Department of the University of California, have been devoted to this work for three months past, and the observations will continue another month.

The determination of the value of this astronomical unit of distance is one of the most famous problems in the science, and a great variety of methods has been used. Perhaps the best determination is that made by Sir David Gill, of the Cape of Good Hope, from heliometer observations of the nearer asteroids. The four hundred small planets —asteroids—discovered up to 1898 all move in orbits situated entirely outside the orbit of Mars. The observations of Victoria, Iris and Sappho, which approach nearer to the earth than any of the other members of the asteroid group, led to the conclusion that the average distance from the earth to the sun is about 92,900,000 miles. The unavoidable errors to which all such observations are subject leave an uncertainty of some 150,000 miles in this value: it may be too large or too small by this amount.

The accuracy of results obtained in this manner depends upon the distance of the observed body from the earth and upon its definiteness as a point of observation. Mars possesses the advantage of being nearer the earth than the asteroids, but this advantage is greatly outweighed by the fact that an asteroid-point can be observed much more accurately than a large planet-disk. Gill's splendid work left much to be desired, but there was no prospect that his value of the unit could be improved with instruments now available.

An asteroid discovered by Dr. Witt in Berlin in 1898, to which he gave the name Eros, is very remarkable in that its orbit lies partly within and partly without the orbit of Mars. It approaches the earth more closely than any other member of our system, except the moon. The forms and relative positions of the orbits of the earth, Eros and Mars are shown approximately by the accompanying diagram, Fig. 1. The

FIG. 1.

orbits of Mars and Eros appear to intersect, but this is merely apparent, from the projections of the two on the plane of the paper. The plane of the orbit of Eros makes an angle of about eleven degrees with the plane of the orbit of Mars (and the earth), and the two orbits are situated like two adjacent links of a chain, without approaching each other very closely.

As soon as the orbit of this wonderfully located asteroid was computed and published, astronomers realized its possibilities for improving our knowledge of the sun's distance. As stated above, an asteroid's value for this purpose depends upon its closeness to the earth. The distance of Eros at this opposition will have a minimum value of twenty-seven million miles. Unfortunately, the more favorable opposition of 1896, when the distance diminished to fifteen million miles, was not available, as the planet remained undiscovered; and an equally good opposition will not occur again for a quarter of a century.

In outline, this method of measuring the

sun's distance is exceedingly simple; but in detail, it is exceedingly complex and technical. The nature of the problem may be explained from Fig. 2.

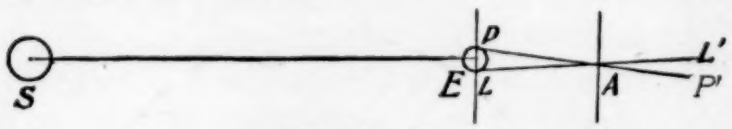

FIG. 2.

If the earth is at E and the asteroid at A, an observer on the earth's surface at P will see the asteroid projected on the sky at P', whereas an observer at L will see it at L'. If the distance PL is known, as it is, and the angle PAL is obtained from the observations, the data for solving the triangle PLA are at hand, and the distance EA may be obtained by simple computation. As a second step in the solution, the orbit of Eros will be determined very accurately, basing the determination upon Newton's law of gravitation. It will then be a simple matter to compute the ratio of the earth's distances from the sun (ES) and the asteroid (EA). The distance EA having already been determined in miles, the desired distance ES will follow.

If two observatories on opposite sides of the earth secure observations simultaneously, say at P (Pukowa in Russia) and at L (Mt. Hamilton), the desired data are theoretically complete; but practically they are insufficient. There are unavoidable errors in the measurement of the very small angle PAL, and in the assumed positions of the two observatories, which will be materially reduced by having observations made at a large number of stations. The direct distance between the Pulkowa and Lick Observatories is about 5,000 miles. This is a base line from which to measure a distance of 27,000,000 miles, and thence the three-and-one-half-fold greater distance to the sun. The form and the dimensions of the earth thus enter directly into the problem. An error of a quarter of a mile in the assumed length of the base line leads to a large error in the final result.

Instead of simultaneous observations made in the morning in Russia and in the evening in America, the angle PAL can be determined by evening and morning measures secured at one station.

The July conference of astronomers at the Paris Exposition afforded an opportunity for a hurried formation of cooperative plans to secure the observations needed. It may be said that every one of the contributing observatories is devoting to this problem all its resources which in any way promise to improve the results. The measures are most advantageously made in November and December; and perhaps a hundred observers are giving their time to this work. The reductions will require one or two years' labor, and the value of the sun's distance, resulting from a combination of all the work of all the observatories, will probably not be available for two or three years.

The Lick Observatory is contributing as follows:

Astronomer R. H. Tucker, assisted by Mr. Crawford, is securing two meridian-circle observations of each of 700 stars, to determine their positions with the utmost accuracy. These positions, furnished by perhaps a dozen or more observers, will form the triangulation system, or groundwork, upon which the whole structure of the determination will be based.

Astronomer W. J. Hussey and assistant-astronomer R. G. Aitken, with the assistance of Mr. Wright and Dr. Reese, are using the great 36-inch telescope five or six nights per week, weather permitting, to measure the evening and morning positions of Eros with reference to the fixed stars in the asteroid's vicinity. The positions of these reference stars will be secured by means of photographs of the regions

taken with eight or ten telescopes, mostly in Europe.

Assistant-astronomer C. D. Perrine, assisted by Mr. Palmer, is employing the Crossley Reflector every clear night to obtain photographs of Eros and its surrounding stars, to furnish the planet's accurate position in the evening, in the morning, and on the meridian. The measurement of these plates will be a heavy task. Fortunately, Professor Rees, Director of the Columbia University Observatory, has volunteered to measure them. Columbia University is the only institution in this country which has had experience in measuring such plates, though many foreign observatories have long been doing similar work.

The planet Eros is now of about the 9.3 magnitude. It is easily visible in a three-inch telescope.

W. W. CAMPBELL,
Director of the Lick Observatory.

ON THE NATURE OF THE SOLAR CORONA, WITH SOME SUGGESTIONS FOR WORK AT THE NEXT TOTAL ECLIPSE.

IN an article on the corona, published in the November number of the *Astrophysical Journal*, I suggested a method by which the existence of the Fraunhofer lines in the spectrum of the corona might be detected. The method was based on the supposition that the light emitted by the particles in virtue of their incandescence, so overpowers the reflected sunlight that the lines are invisible. That the coronal light is strongly polarized is well known, and there is scarcely any doubt but that the polarized light is reflected sunlight. If now a Nicol prism be placed before the slit of the spectroscope in such a position as to transmit the polarized radiations, these will be allowed to pass with almost undiminished intensity, while the emitted or unpolarized light will be reduced in intensity by one-half. The great change in the ratio resulting might easily be sufficient to bring out the dark lines distinctly. I feel firmly convinced that this experiment should be tried at the Sumatra eclipse of next May, for I have successfully accomplished it in the laboratory with an artificial corona. It was found that a gas flame in a strong beam of sunlight shone with a pure bluish-white light, due to the reflection or rather scattering of the sunlight by the minute carbon particles.* The flame thus illuminated showed the Fraunhofer lines distinctly, but by reducing the intensity of the sunlight a point was reached at which they disappeared, and the spectrum appeared continuous. The light scattered by the flame was found to be *completely* plane-polarized in certain directions, giving us just the required conditions, namely particles emitting a continuous spectrum, and scattering a polarized solar spectrum. In front of the slit of the spectroscope a Nicol was arranged in such a manner that it could be drawn into and out of position by a cord. The Fraunhofer lines could be made to appear by sliding the Nicol in front of the slit, and disappear by drawing it away. While it does not by any means follow that the use of a Nicol on the actual corona will bring out the lines, the experiment seems to be well worth trying, as it would furnish further information regarding the relative intensity of the emitted and reflected light. Another interesting point is that the minute particles in the flame do not scatter the longer waves, the flame reflecting practically no red or orange light. Thus the Fraunhofer lines can only be traced up to about the D lines. By gradually reducing the intensity of the sunlight they disappear first in the yellow, then in the green, blue, and violet in succession.

* A photograph of the flame with a spot illuminated by powerful convergent beams of sunlight furnishes a beautiful proof of the existence of solid particles in the flame.

This indicates that our chances of detecting the lines in the spectrum of the corona will be greatest in the photographic part of the spectrum. Moreover, it appears to explain the absence of radiant heat in the light emitted from the corona, the particles being too small to scatter these longer waves to any appreciable extent. Abbott, of the Smithsonian party at Wadesboro, found the corona cold in comparison with his bolometer, and infers from this that the corona neither reflects sunlight nor emits light in virtue of incandescence, expressing the opinion that the luminosity is analogous to that of vacuum tubes transmitting electric discharges. It seems to me that the polarization of the coronal light makes this theory untenable, and that the absence of heat rays can be explained fully by the small size of the particles. I am aware that the absence of radiant heat in the *emitted* light has yet to be accounted for. My own notion, based on experiments which are now in progress, is that the reflected or scattered light is vastly in excess of the emitted, and that the absence of the Fraunhofer lines is more probably due to line-of-sight motion of the particles, than to simple drowning out by emitted light.

My experiments on the ratio of emitted to reflected light of a body brought to incandescence by powerful solar radiation are not yet completed, consequently I do not yet feel prepared to make any very positive statement in regard to this matter. A full account of this work will appear shortly in the *Astrophysical Journal.*

Any observers planning to use a Nicol prism in connection with a spectroscope in the manner described will find a gas or candle flame illuminated with a beam of sunlight concentrated by means of a large mirror or lens, extremely useful in making preliminary experiments.

For work on the polarization of the corona I believe that the artificial corona described elsewhere will be found most useful for preparatory work. Not only is it polarized, and polarized in the same way as the real corona, but it resembles it in a most striking manner, and can be easily made of the same brilliancy. It would be well to work with particles of different size, giving different percentages of polarization, and the picturesque refinements for producing the polar streamers could of course be omitted. For work of this sort it would be well to use a lamp with a ground glass bulb, as the conditions of illumination would then more nearly approach those in the real corona.

Data regarding the plane of polarization in the streamers would be useful in formulating a theory of the streamers. These, it seems to me, can be conceived as formed in two ways: they may be streams of coronal particles moving in curved paths, in which case the plane of polarization should be everywhere strictly radial, or what is extremely improbable, they may be caused by divergent beams of light coming from the polar regions of the sun and moving in curved paths, owing to the rapid decrease in the refractive index of the sun's atmosphere in an outward direction. If this were the case, the plane of polarization would turn with the streamer.

This latter hypothesis is extremely visionary, and I do not present it seriously, for it is almost impossible to conceive of any way in which the isolated beams of light could be formed, unless perhaps by vortex funnels more highly luminous than the surrounding surface of the sun. Such fanciful speculations are hardly worth indulging in, though they have interested me for the moment in connection with the matter of the possible curvature of light rays in the sun's atmosphere alluded to in a recent paper by Julius in the *Astrophysical Journal.*

R. W. Wood.

University of Wisconsin.

CHICAGO SECTION OF THE AMERICAN MATHEMATICAL SOCIETY.

THE eighth regular meeting of this Section was held at the University of Chicago on Thursday and Friday, December 27 and 28, 1900. The Section was organized in April, 1897, under a by-law of the Society which provides for conducting in any locality periodic meetings for the reading and discussion of mathematical papers, and since then has met twice a year, in April and December. During this period a total of 128 papers, by fifty-two different persons, have been read before the Section.

The election of officers, which occurs regularly at the Christmas meeting, resulted in the re-appointment of the Secretary, Professor Thomas F. Holgate, and the choice of Professor E. J. Townsend and Professor James B. Shaw for members of the Program Committee.

The following papers were read:

1. PROFESSOR E. H. MOORE: 'On the uniformity of continuity.'

2. PROFESSOR ARTHUR S. HATHAWAY: 'Quaternions and four-fold space.'

3. PROFESSOR IRVING STRINGHAM: 'On the geometry of planes in a parabolic space of four dimensions.'

4. DR. F. H. SAFFORD: 'Flow of heat in two dimensions.'

5. MR. A. C. LUNN: 'Certain mathematical aspects of experimental science.'

6. MR. E. A. HOOK: 'Some properties of circulating decimals.'

7. PROFESSOR ARNOLD EMCH: 'Note on the congruences of twisted curves.'

8. PROFESSOR H. B. NEWSON: 'A generalization of the Wessel-Gauss-Argand diagram.'

9. DR. F. R. MOULTON: 'On straight line solutions of the problem of n bodies.'

10. DR. GILBERT A. BLISS: 'Geodesic lines on an anchor ring.'

11. MR. FRANZ A. LA MOTTE: 'On the determination of the algebraic equations invariant under Tschirnhausen transformations, with the parameter representation of all such irreducible equations, with rational coefficients, of the third and fourth degrees.'

12. PROFESSOR E. J. TOWNSEND: 'Functions of two real variables which are continuous with respect to each variable.'

13. PROFESSOR L. E. DICKSON: 'The group of the equation for the twenty-seven lines on a general cubic surface.'

14. PROFESSOR OSKAR BOLZA: 'Concerning the expression of Abelian integrals in terms of a fundamental set of integral functions.'

15. DR. J. C. FIELDS: 'Proof of the Riemann-Roch theorem and of the independence of the conditions for adjointness.'

16. PROFESSOR OSCAR SCHMIEDEL: 'Two reduction formulas applicable to certain particular integrals.'

17. PROFESSOR E. B. SKINNER: Some forms which remain invariant with respect to certain ternary monomial substitution groups.'

18. PROFESSOR JAMES B. SHAW: Note indicating a new development of a determinant.'

19. PROFESSOR E. H. MOORE: 'On double limits.'

20. PROFESSOR E. H. MOORE: 'Concerning the fundamental propositions of the theory of proper definite integrals.'

21. MISS IDA M. SCHOTTENFELS: 'Proof of the existence of a particular substitution group of degree 21 and order 20160.'

In addition to the above Professor Hathaway presented a paper introducing a general discussion on the subject 'Pure Mathematics for Engineering Students.'

THOMAS F. HOLGATE,
Secretary of the Section.

EVANSTON, ILLINOIS.

WISCONSIN ACADEMY OF SCIENCES, ARTS, AND LETTERS.

THE thirty-first annual meeting of the Academy took place at Milwaukee, December 27 and 28, 1900. The following papers were read and discussed:

'An example of a theoretical system of weight-factors, of ready application in the solution of observation equations,' by Albert S. Flint.

'Harmonic curves of three frequencies.' (Second paper.) With exhibition of stereograms drawn by E. A. Hook, by Charles S. Slichter.

'On repeating decimals,' by E. A. Hook.

'On an improved method of determining latent heat of vaporization,' by Louis Kahlenberg.

'A campaign cry of 1844,' by H. J. Desmond.

'Early political platforms in Wisconsin,' by John G. Gregory.

'Personal names, their etymology,' by James D. Butler.

'Shakespeare's knowledge of criminal psychology,' by Frank C. Sharp.

'Determinism, decrees and immutable law,' by Charles C. Caverno.

'Some recent observations on the migration of birds,' by H. A. Winkenwerder.

'The plankton of Green Lake and Lake Winnebago,' by C. Dwight Marsh.

'The cause of cleavage in rocks,' by C. K. Leith.

'The supposed lessening of geyser activity in the Yellowstone National Park,' by D. P. Nicholson.

'The orientation of stream channels as related to geological structure,' by William H. Hobbs.

'The old tungsten mine at Trumbull, Ct.,' by William H. Hobbs.

'The future of the clay and cement industry in Wisconsin,' by Ernest R. Buckley, Associate Director of the State Geological Survey.

The following papers were read by title:

'On the thermal conductivity of common woods,' by L. W. Austin and C. W. Eastman.

'The expansion of wood due to the absorption of water,' by L. W. Austin, G. S. Cassels and W. H. Barber.

Frank Chapman Sharp,
Secretary.

SCIENTIFIC BOOKS.

Foundations of Knowledge. By Alexander Thomas Ormond, McCosh Professor of Philosophy in Princeton University. New York, The Macmillan Co. 1900. 8vo. Pp. xxvii + 528. Price, $3.00.

Without mincing words, it may be affirmed at once that Ormond's work is a very considerable performance. Not only this. Symptomatic books on philosophy have been none too many these last twenty-five years, and the volume before us betrays many symptoms of interest in relation to matters fundamental. Accordingly, even if it be 'meant as a first rather than a final word on the topics with which it deals' (Preface, xxv), it cannot escape the sharp analysis that all primary achievements deserve and, indeed, demand. Further, the 'General Introduction' betrays so excellent a sense of the recent historical situation, especially in British-American thought, that the things Ormond has left unsaid throw no little light on those to which he has committed himself. As the book is a first word, and largely epistemological at that, in view of favors to come, I should like to express the hope that, in Ormond's creed, things are lawful in epistemology which must be suppressed sternly in metaphysic.

The main body of the exposition has been divided into *three* 'Parts.' In the *first*, Ormond deals with 'Ground-Concepts of Knowledge.' What he attempts here might be called a clearing of the air. That is to say, centuries of discussion and of common usage have caused many hoary associations to cluster round certain terms. Every one is aware what the words, 'Experience, Knowledge, Reality,' mean; yet, equally, no one is aware. Otherwise, these counters cover so much that few stop to deploy their implications, and the interpretation alters with the ear that hears. Personal tendencies, customary environment of intellectual habit and the like, vary from man to man, from community to community. The 'experience meeting' of the pietist, the 'experience' demanded by electors to a vacant office, 'experience' with Mr. Spencer, and 'experience' as the latter-day idealist thinks of it, are by no means the same affair. Accordingly, with true instinct, Ormond proceeds, first, to state his view of the general implications of 'Experience, Knowledge, Reality,' and a very sensible, non-partisan view it is. "We may define experience as the sum of these personal activities by means of which a conscious self reacts upon its object or not-self, and translates it into realized content, these activities being inclusive of thought, feeling and will; or, objectively—the system in which these activities are included" (50). "The notion of reality includes a synthesis of being and manifestation" (64). "The method of knowledge, as we have conceived it, is an embodiment of the inner dialectical process by which the content of experience is reduced to the content of knowledge" (104). Such are the essential statements.

The *second* Part reviews the 'gradual development of the knowing processes,' and is entitled, 'Evolution of the Categories of Knowledge.' At this point, even if one have not noted its presence previously, the modern outlook of the work becomes abundantly apparent. To be specific, the contemporary de-

mand for a dynamic, as opposed to a static, view of experience receives satisfaction. After analyzing the nature of the categories, Ormond proceeds to thresh the old straw of Space, Time, Quantity, Quality, Cause and Substance, offering, however, certain stimulating novelties, particularly in his treatment of the two last; this, even if we demur to his allegations that 'The notion of agency is a persistent element of that of cause' (174), and that 'the category of substance represents the mode by which experience realizes those points of rest or permanence in its world which are necessary in order to render the series of changes possible' (192). Thence he passes to the subject so much agitated and so vitally interesting today—to 'Community or Interaction, the Dynamic Consciousness, the Æsthetic Categories, the Subject Consciousness, Categories of the Subject Consciousness, the World of Individuals, the Consciousness of Community.' The point at which he elects to take up the 'Subject Consciousness' is worthy of especial remark. Every praise ought to be accorded this abundant recognition of the newer insights and problems. Similarly, one cannot fail to be struck favorably with the frank manner in which Ormond tackles this task, even although he proceeds from presuppositions that antedate the dynamic categories, do not grow out of them, nay, as the strong probability runs, are forbidden, if not exploded entirely, by them.

To readers of SCIENCE, the *third* Part presents much matter of genuine interest. Greatly daring, Ormond has christened it 'The Transcendent Factor in Knowledge.' But names need not frighten us, when we discover that he places within these dread limits that vital modern problem, the relation between science and philosophy. Moreover, in outlining this relation, he formulates what must be taken as his characteristic contribution to pending metaphysical inquiries—the concept of *transcendency within experience.* "We have seen that science deals with the transcendent and that metaphysics has something to do with experience. * * * The discussion * * * has put us in a position to see that one of the points of difference consists in the fact that the aim of science, in so far as it finds it necessary to recognize the transcendent at all, is simply to employ the concept of it in determining the nature of the relative in experience. This accounts for the fact that science stops in its attempt to define the transcendent at that point where that process ceases to be necessary to the definition of the relative. Metaphysics, on the other hand, is directly concerned with the determination of the transcendent, not so much as a principle for the definition of the relative in experience, as for the complete determination and satisfaction of the relative experience as a whole through the grounding of it in that which is absolute and complete. Having for its aim then the grounding and completing of the relative experience itself in that which transcends it, the determination of this transcendent nature becomes a matter of direct interest to it, and its attitude toward the transcendent is from the outset, therefore, different from that of science" (323–4).

At this point precisely, one must take issue with the author. If what he says about the mission of metaphysics be true, then science may once more say to philosophy what she has sometimes said before: 'All right, I'll keep the inside of the house, you may do as you will with the outside.' For, by definition, the transcendent happens to be the super-experiential, that concerning which anything may be said; and we cannot too often recall that anything and nothing are identical. To attempt to fill out this word with meaning, as Ormond seems to do again and again, is, of course, to negate transcendency. The fact is that Ormond (this is part of his great interest) represents a point of view which, unconsciously, mediates between the old pre-Kantian dualism and the desiderated organic monism—a theory still in the air, but, nevertheless, the sole defensible ground of scientific dualism, and also of the conservation of those aspects of experience which Ormond has in mind when he writes 'transcendent.' Had he ploughed longer with the heifer of science, he might have earned vouchers admitting him to this philosophical paradise; as it is, he who runs may read the flaw in the credentials presented here.

Consider the following passages, for example. "The real, then, is possible content of con-

sciousness and will be found to be a transcendent term in relation to an actual consciousness. It will include the realized content of the actual consciousness; also that which is simply present *in* or *to* consciousness, together with an extra-conscious sphere which exists as yet only as implicate or postulate" (90). The *extra*-conscious as implicate of consciousness! Are we able to attach any clear idea to what is either unthinkable or else a concatenation of mere words? Again, in Ormond's definition of Category, the cloven-hoof of the Devil whose delight lies in shattering human experience, plants itself firmly. "A category may then be defined; subjectively, as the constitutional mode through and in which the subject-consciousness penetrates its world, and reduces it to ideal content, and objectively, as the form which the world or not-self is obliged to assume in order to present itself to and in consciousness and become content of its world-idea" (117). 'Obliged' were truly a symptomatic term. The problem of the unity of experience seems to be trebled here. For we have a hint of no less than three universes, to wit, a subject-universe, an object-universe and a category-universe. The conception that ideas are forms (the conception, be it remembered, which has retarded so seriously metaphysical advance, and progress in unitary understanding of the world, by rendering science and philosophy alien from each other) has once more elbowed out the hopeful contemporary insight, that ideas are forces; that 'matter,' in so far as amenable to scientific treatment, is intelligent, because intelligible; that the universe is a universe, because built in one piece, and all inclusive. Yet again, (1) "Without cause no beginning of change would be conceivable, but without substance the very notion of change would be absurd. Cause is the principle in accordance with which changes are organized into a mutually dependent system; substance is the principle which in its notion of permanence supplies the condition which our world demands in order that the system of changes may be possible." * * * (2) "The points of rest are relative, therefore, and have their common presupposition in the central activity of self-consciousness" (192–3). Here a very old friend puts in appearance, no doubt with face washed or smeared somewhat, yet with character unaltered. So far as the statement of *process* goes, (1) and (2) land at last in mutual exclusions, as they have ever done.

As Ormond is aware, no modern thinker would deny the existence or the potency of the element which he calls 'transcendent.' But the moment you term it 'transcendent,' you turn it into a kind of waste-paper basket, the convenient receptacle for every sort of inconvenient question. For instance, gravitation is an undeniable fact for the physicist's experience. But whenever you suggest its 'transcendency,' as Ormond's reasoning would, you leave the realm of experience and serve yourself some fine, mysterious feeding. The truth is that gravitation, like other 'ultimates,' is transcendental, and in the sole legitimate sense of this term; that is to say, it is constitutive. Here we come to ourselves again, and well within the sweep of experience. This solid footing reached, we cannot forbear to make the somewhat cruel point that the 'transcendent' is all too apt to provide tranquilizing refuge for those who have learned nothing and forgotten nothing. With these mummies of intellect Ormond has no commerce. But he has wandered perilously near their catacombs; nearer than he knows, possibly, when he writes thus: "There is no reason to suppose then that the distinction between the absolute and relative is other than ineradicable, but, on the contrary, the whole trend of experience tends to confirm what is also a necessity of thinking; namely, that the grounding of any distinction in the absolute is the highest guarantee we can have of its reality and permanence" (419–420). Moreover, the results of this excursion into a field so perilous crop out continually in the curious attitudes he adopts so often in the third Part. What is the man, who is looking for guidance from the very last word uttered in metaphysics, to make of this? "The notion of revelation will be completed then in the idea of the direct function of the transcendent other in introducing a new and superordinary content into our consciousness, the subjective condition of the reception and realization of which is that state of

the subjective consciousness to which the term inspiration is applicable" (491). As a piece of acrobatic audacity, excellent! Yet we may well doubt whether a thinker standing with one foot firmly planted on the Rock of Ages, the other pointing heavenward, has struck the attitude most conducive to progress. Of course, he is so interesting that we should dearly love to secure his photograph to show to our scientific friends, who would be tickled rather than impressed.

To make an end; this book constitutes one of the freshest and most stimulating contributions to philosophical inquiry that we have had for many a day. It represents an enormous advance on Ormond's earlier work. And if the author could but shake himself free from the hypnotic suggestion now exercised over him by the 'transcendent,' he might very easily, in that further discussion hinted in his Preface and looked for with lively expectation by the present writer, produce a book as superior to this as this is to 'Basal Concepts in Philosophy.' In short, Ormond stands on the very edge of the pathway to really constructive leadership.

It remains to say that the publishers have executed their part admirably. Printed at the famous Glasgow press, the book, despite its 540 pages, is light to hold and easy to read. In another edition the usefulness of the index might be much enhanced.

R. M. WENLEY.

UNIVERSITY OF MICHIGAN.

Chemie der Eiweisskörper. Von DR. OTTO COHNHEIM. Braunschweig, F. Vieweg und Sohn. 1900. Pp. 315.

In recent years no book dealing with the proteids and their derivatives has appeared which is so comprehensive and satisfactory as Cohnheim's 'Chemie der Eiweisskörper.' The references to the literature of the subject are unusually exhaustive and include practically every important contribution made prior to 1900. The work of American physiological chemists is cited mostly from abstracts, and some of the more recent papers have not yet found their way into the book; it is to be hoped, however, that the time is approaching when American papers will be studied at first hand in all European laboratories. Cohnheim's 'Eiweisskörper' is something more than a mere compilation of the results of the chemical investigation of the proteids. The author's critical study of the voluminous literature on the subject is indicated by the discriminating judgment with which he has treated many controversial topics and by the succinct manner in which many of the unsolved problems are pointed out. The book is essentially a critical review, and the mode of presentation (for example, of heat coagulation and other physical modifications of the proteids) is decidedly more suggestive than that of most recent writers. In the classification of the proteids Cohnheim follows the latest edition of Hammarsten's 'Textbook,' without claiming for this grouping anything more than a temporary usefulness. The author has proposed, as an innovation, to class those proteids usually termed nucleoalbumins, of which casein is the best defined type, with the simple proteids (Eiweisskörper) under the name of phosphoglobulins; the latter would thus be differentiated more clearly from the true nucleoproteids (in the sense of German writers) to which they bear resemblance only in a few superficial characters. The vegetable globulins (Phytoglobuline) are also treated in the old group of nucleoalbumins, although in the light of our present knowledge they compare more closely with the globulins of animal origin, and many of them, at least, are free from phosphorus.

Without giving a detailed survey of Dr. Cohnheim's book, a few of the better features may be referred to. The analogy in chemical behavior between the proteids and the 'pseudobases' of Hantzsch is pointed out, and a very complete account of the decomposition products of proteids is given, especially of the carbohydrate groups lately identified by various investigators. The sulphur content of the proteids is discussed in detail; and the literature regarding the nitro- and halogen compounds—almost entirely the outcome of very recent work—is collected and reviewed for the first time. In his treatment of the albumoses and peptones the author follows the classification introduced by Hofmeister and his pupils, although the

older worker is by no means overlooked. The more thoroughly studied substances, such as egg- and serum-proteids with their crystalline forms, are taken up at length; and the muscle proteids are presented in the light of v. Fürth's work. To the physiological chemist who has occasion to refer frequently to recent investigations on the nucleoproteids and their derivatives, the careful summary of research in this field of work will be found most helpful. Thirty pages are devoted to the chemistry of hæmoglobin, and the chapter on the albuminoids is fairly exhaustive.

The volume is appropriately dedicated to the memory of W. Kühne.

Lafayette B. Mendel.

Yale University.

Treatise on Hygiene. By J. Lane Notter. Second edition. P. Blackiston's Sons & Co. 1900.

This is the second edition of the well-known book of Notter and Firth, which itself was founded on the still earlier treatise of Dr. A. E. Parkes.

It is a very comprehensive work, containing nearly eleven hundred pages, and treating of a very wide range of topics, such as, for instance, water, air, food, heating, ventilation, clothing, exercise, construction of houses, vital statistics, and military and naval hygiene.

The book as a whole is excellent, the material is well selected, and the views thoroughly modern. Treating such a wide range of subjects as the authors do, they must necessarily give frequently the opinions of others rather than their own, and this causes at times, where opinions differ, a lack of authority. In a few places remains of earlier editions crop out; thus under malarious soils no mention is made of the mosquito, but in another portion which is devoted to malaria the relation of the insect to the disease is fully stated.

In some places important omissions occur: thus in the preservation of milk cold is hardly alluded to, yet it is almost as important as cleanliness. The number of bacteria considered suitable in milk, 400,000 per cc., seems very high. Taking the book as a whole, it is one that can be thoroughly commended to those who have either a general or a special interest in the study of hygiene.

W. H. Park.

SCIENTIFIC JOURNALS AND ARTICLES.

The *Journal of Comparative Neurology* for December contains the following articles: 'The Giant Ganglion Cells of Catostomus and Coregonus,' by J. B. Johnston, West Virginia University. The author figures and describes successful Golgi preparations of these transient nerve cells and compares them with the sensory cells in the spinal cord of *Amphioxus* and *Petromyzon*, whose fibers reach the periphery without effecting relations with cells of the spinal ganglion. It is suggested that they are belated neural crest cells which failed to migrate into the spinal ganglia. 'Arrangement and Terminations of Nerves in the Œsophagus of Mammalia,' by Lydia M. DeWitt, University of Michigan. Investigations on the cat and rabbit by the *intra vitam* methylene-blue method. The following types of nerve termination are described: typical motor and secretory fibers from sympathetic ganglia of Auerbach's and Meissner's plexuses, motor fibers from the ventral horns of the spinal cord for the striated muscle fibers of the œsophagus, sensory termini in the mucosa from cells of spinal ganglia, and other sensory fibers, apparently wholly confined to the sympathetic nervous system. 'The Vibrissæ of certain Mammals,' by J. Franklin Messenger, University of New Mexico. The innervation of the hair follicles is figured and a peculiar erectile vascular pulvinus is described. 'The Ophthalmic and Eye Muscle Nerves of the Cat Fish (*Ameiurus*),' by I. S. Workman, Denison University. The cat fish is shown to resemble other teleosts in the absence of a *r. ophthalmicus profundus*. The nerve so named by some anatomists is the *r. ophthalmicus superficialis V*, to which are added facialis fibers for terminal buds on the top of the head. The eye muscle nerves show a ganoidean arrangement. 'On the Homologies of the Chorda Tympani in Selachians,' by H. A. Green, Denison University. The selachian types examined exhibit a pre-spiracular nerve, in addition to the *r. palatinus* and the true pre-trematic ramus for the pseudobranch, which runs down between the

mandible and the hyoid arch and whose morphological relations seem to be the same as those of the mammalian chorda. The editors announce the addition of Dr. Lewellys F. Barker, of the University of Chicago and Rush Medical College, to the staff of editorial collaborators.

IN an article entitled 'The Recent Development of Method in Theoretical Physics,' published in the January *Monist*, Professor Ludwig Boltzmann, formerly of Vienna but now of the University of Leipsic, has presented a trenchant criticism of the philosophical tendencies now dominating physical research. Professor Boltzmann is an outspoken votary of the classical or atomistic physical philosophy which culminated in the labors of Faraday and Maxwell; and after rapidly sketching the rise and development of the mechanical philosophy he proceeds to subject to searching scrutiny the views of the energeticians (Ostwald, Helm, etc.) and the phenomenologists (Kirchhoff and Mach). While not underrating the achievements of either of these two recent schools of physical theory, he asserts that the early acquisitions of the atomistic inquirers could never have been reached by energetics or by phenomenology. To the same number of *The Monist*, MM. Vaschide and Piéron, of Paris, France, have contributed an erudite article on 'Prophetic Dreams in Greek and Roman Antiquity,' for which they have collected from the original sources all the data in the ancient writings relating to oneirology. The remaining articles are an 'Introduction to a Psychological Study of Religion,' by Professor James H. Leuba, and 'Jew and Gentile in Early Christianity,' by Dr. Paul Carus.

THE December number of the *American Geologist* contains the following articles: 'Notes on the Geology and Petrography of Monhegan Island, Maine,' by E. C. E. Lord of Washington, D. C. The works are described as granitic, containing feldspar, olivine, pyroxene and hornblende. The rocks are analyzed petrographically and chemically and compared with rocks from other districts. The mass is frequently crossed by acid and basic dykes which are described and analyses given. 'The Mineralogical and Petrographic Study of the Gabbroid Rocks of Minnesota,' by N. H. Winchell, contains Chapters VIII. to X. inclusive and concludes the series. Chapter VIII. contains a discussion of Quartz Gabbro, in which is given the minerals and their occurrence together with their chemical composition. Chapter IX., Silico ferrolyte, contains a discussion of a rock extremely rich in magnetite containing numerous grains of quartz. This name has been proposed by Mr. Winchell to distinguish the rock from the ferrolyte of Wadsworth, which it resembles. Chapter X., 'Résumé and Conclusions,' contains discussions of the comparative petrography, the mineralogical and chemical composition of the various types of rock studied in the preparation of the report. Next is an interesting article on 'Meteorology of the Ordovician,' by F. W. Sardeson, which is followed by the usual editorial comments, a review of recent geological literature and personal and scientific news.

DR. A. DE WATTEVILLE has resigned the editorship of *Brain*. When accepting his resignation the Council adopted the following resolution: "The Council accepts with great regret Dr. de Watteville's resignation of the editorship of *Brain*, and desires to take this opportunity of recording the deep debt of gratitude that the Society owes him for the way in which he has conducted the Journal for the past twenty years. The Council feels that parting with Dr. de Watteville is an event of great moment to the Society, for he has not only brought *Brain* to a high standard of perfection and secured for it a great European reputation, but even the existence of the Journal at the present time is due to his energetic action at a critical juncture in 1880. Moreover, the Council is mindful that the Society itself took origin on Dr. de Watteville's initiative, at a meeting held at his house, on November 14, 1885."

SOCIETIES AND ACADEMIES.

GEOLOGICAL SOCIETY OF WASHINGTON.

AT the eighth annual meeting, held December 19, 1900, the following officers were elected for the ensuing year:

President, J. S. Diller; *Vice-Presidents*, C. W. Hayes and G. P. Merrill; *Treasurer*, M. R. Campbell; *Secretaries*, David White and F. L.

Ransome. *Members-at-large of the Council*, Bailey Willis, A. H. Brooks, W. Lindgren, G. O. Smith, T. W. Stanton.

The address of the retiring president, Mr. Whitman Cross, on 'The Development of Systematic Petrography in the Nineteenth Century' was delivered in connection with this meeting.

At the 108th regular meeting, held January 9, 1901, the following papers were presented:

N. H. Darton: *Comparison of Stratigraphy of the Black Hills with that of the Front Range of the Rocky Mountains.*

After several years of detailed investigation of the stratigraphy of the Black Hills in South Dakota and Wyoming, a preliminary examination has recently been made of the region southwest to and along the front ranges of the Rocky Mountains across Wyoming and Colorado. The Black Hills are due to a local expansion of a branch of the Laramie range, but the connection underlies a country in great part covered by Tertiary deposits. In the vicinity of Hartville, about 125 miles southwest of the Black Hills, there is a local uplift on this line, affording extensive exposures of formations from the crystalline schists part way up the Mesozoic column. The stratigraphy is here very similar to that of the Black Hills, and all the principal formations from Lower Cretaceous sandstones to the Lower Carboniferous limestone can be distinctly recognized. Along the flanks of the Laramie range, and southward into Colorado, the formations present considerable change, but numerous features of close relationship were observed. In the fine sections at Morrison, west of Denver, there was found an extension of the Purple (Minnekahta) limestone of the Black Hills, having precisely similar stratigraphic relations in the Red beds, and containing some of the same Permian fossil, although these are scarce and not well preserved. The limestone was traced south for a considerable distance and found to merge into a sandy bed which was finally lost in the great mass of coarse red deposits in the vicinity of the Garden of the Gods. Its very distinct occurrence at Morrison affords the means for a precise correlation with the Black Hills region. The underlying mass of coarse sandstone lying against the crystalline rocks represent portions or perhaps all the Carboniferous formations of the Black Hills. The Red beds overlying this Minnekahta limestone at Morrison are gypsiferous shales similar to those of the Red Valley encircling the Black Hills. The Morrison formation lying next above, is, as previous observers have pointed out, the equivalent of the Alantosaurus (Beulah) shales and the marine Jurassic which was traced as far south as the Hartville region, is lacking in the Morrison section. The lower Cretaceous sandstone in the Black Hills has not been recognized in Colorado. The Benton formation presents the same three divisions through the Black Hills region as were determined by Gilbert in southern Colorado. In the valley of the Purgatoire in southern Colorado the Red bed series are represented by red sandstones of moderate coarseness, in the upper bed of which was discovered a bone of a Bolodont which is thought to be of Triassic age. The overlying series of gypsum, limestone, and shale yielded no fossils, but probably comprises a representative of the Morrison formation, for its upper part it least has all the characteristic features of the Alantosaurus shale. It is overlain by so-called Dakota sandstone.

Alfred H. Brooks and Arthur J. Collier: *Glacial Phenomena of the Seward Peninsula.*

The Seward Peninsula, stretching out toward the Siberian coast from northwestern Alaska, separates the Arctic Ocean from Bering Sea.

It consists, topographically, of low, rounded hills whose gentle slopes are often broken by well-marked benches. Above this upland, rise three notable mountain masses. The Kiglowaik range, whose highest peaks reach an elevation of 4,500 feet, is a rugged mountain mass lying some 30 miles north of Nome. To the northeast of this range is another mountain mass, which, extending to the northeastward for some 30 miles, sweeps around the headwaters of Fish River, and joins the mountains east of Golofnin Bay. The York Mountains, the third mountain mass, extend inland from Cape York.

In this region there is no evidence of general glaciation. In fact, there is positive proof

against it. The three mountain masses have, however, as shown by studies of the past season, been centers of local glaciation. In the Kiglow-aik range the valleys are glaciated to an elevation of 500 feet above the valley floor, and the moraines marking the limits of this glaciation were deposited close to tide-water. The evidence of ice action consists of cirques, U-shaped valleys, morainic topography, and glacial erratics. Indeed, in some of the higher valleys still exist the shrunken remnants of the former valley glaciers. These small glaciers, in latitude 65, are, as far as known, the most northerly on the continent.

The high benches and terraces show that the western part of the peninsula has been elevated 600 or 800 feet in recent times. This elevation, however, antedates the maximum extension of the valley glaciers above described.

A. C. SPENCER: *The Physiography of the Copper River Basin, Alaska.*

The observations made by Messrs. A. C. Spencer and F. C. Schrader during the summer of 1900, establish the existence of a peneplain in the Chugatch Mountains, between the coast and the interior basin of the Copper and Chitina (Chittyna) rivers, and in the adjacent mountains at the heads of the Chitina, White and Tanana rivers.

The peneplain is now a dissected plateau with an elevation of more than 6,000 feet. Above it rise Mt. Blackburn and Mt. Natzahat to elevations of several thousand feet, the former, at least, being of extrusive origin. The age of this marked physiographic feature is not earlier than late Cretaceous nor later than Miocene. As the Eocene and Miocene are known to have been periods of baseleveling in western North America, it is probable that the peneplain is of Tertiary age. Whether it should be correlated with the Yukon plateau, considered as Miocene, or whether it is an older feature, has not been determined. It is of the same order of maturity as that plateau, and if it can be shown to be of the same age, its present altitude, several thousand feet above the adjacent portion of the great interior plateau of Alaska, shows that there has been faulting along the scarp which the St. Elias Range and its northwestern extension present towards the northeast.

F. L. RANSOME,
DAVID WHITE,
Secretaries.

BIOLOGICAL SOCIETY OF WASHINGTON.

The 332nd meeting was held on Saturday evening, January 12th.

W. H. Dall exhibited a skiagraph of a number of univalve mollusks, taken by a comparatively short exposure to the X rays, and yet in spite of their calcareous nature showing the structure and form of the interior whorls very distinctly.

Vernon Bailey showed a specimen of a commercial skin of a grebe, saying that the grebes, as well as other water fowl, were being killed in great numbers in the shallow lakes of Oregon and Washington, particularly in the Klamath lakes, and that it was to be hoped that something might be done to protect these birds before it was too late.

William Palmer exhibited a series of specimens of the Cuban branching fern, *Gleichænia dichotoma*, describing its various stages of growth and comparing them with those of other species.

Frank K. Cameron spoke of 'The Formation of Black Alkali by Plants,' stating that it has long been believed that certain plant varieties cultivated on the arid soils of the West can cause an accumulation of sodium carbonate or 'black alkali.' This question has received some attention in the past, notably by Hilgard in California and Goss in New Mexico. An examination of the question in the laboratory of the Division of Soils, U. S. Department of Agriculture, indicates that in some cases there is an enormous accumulation of sodium in the leaves and stems of certain plants, more than sufficient to combine with the inorganic acids present and therefore in organic combination. On decay this material yields considerable amounts of alkali carbonates, which accumulate on account of the peculiar conditions of moisture and drainage which obtain for soils in arid regions.

The study has led incidentally to a discussion of the phenomena involved in the absorption of mineral salts by plants, from the point of view of the chemist; and lines of investigation

of possible value to the physiologist are tentatively suggested.

The detailed description of the study will appear at an early date in the 'Report of the Field Operations of the Division of Soils for 1900.'

T. H. Kearney discussed 'The Effect of Alkali Salts on the Growth of Seedling Plants,' describing a series of experiments conducted with the assistance of Dr. F. K. Cameron of the Division of Soils, Department of Agriculture, in order to ascertain the relative injurious effects upon plants of the salts characteristic of the so-called 'alkali' lands of the Western States. The salts employed were Na_2Co_3, $MgSO_4$, $MgCl_2$, Na_2SO_4, $NaHC.O_3$, NaCl, $CaCl_2$ and $CaS.O_4$, enumerated in the order of their toxicity so far ascertained; the first of these was the most harmful. Solutions were made in each case on the basis of a normal solution, that is, of the equivalent in grams per liter of the reacting weight of each salt. Young seedlings of *Lupinus albus* were selected for these experiments because of their sensitiveness to toxic substances, and because when proper conditions of germination are maintained their clear, straight radicles are admirably adapted to recording the rate of growth and other changes. The importance of continuing the investigations with other plants of widely different relationships was nevertheless emphasized.

One experiment was made with water heavily charged with CO_2, in order to ascertain whether the H ions set free by the dissociation of the hypothetical H_7CO_3 might not prove toxic to the radicles. No harmful effect was obtained.

$CaCo_3$ and even $MgCo_3$, added in powdered form to solutions of NaCl and Na_2SO_4, tended to neutralize the injurious effects of those salts. Still more marked was the influence of $CaSO_4$, when added to very toxic solutions of NaCl, in checking the action of the latter.

Solutions of many of those salts, *e. g.*, Na_2Co_3, Na_4SO_4 and CaClr, when of a dilution well below the toxic limit, served as actual stimuli to growth.

O. F. Cook presented a paper on 'The Origin of the Cocoa Nut,' prefacing his remarks with the statement that the origin of many of our domesticated plants was unknown, and in other cases obscure. It was extensively believed that the cocoa nut was a native of Asia and introduced into tropical America, but the speaker showed by quotations from early Spanish writers that it was here at the time of the discovery of America. De Candolle's reasons for and against the American origin of the cocoa palm were critically reviewed and the conclusion reached that the objections to the American origin could be successfully combated.

Attention was drawn to the fact that, contrary to universal belief, the cocoa nut could not withstand exposure to salt water, and that it was not likely that so delicate a palm had received its wide distribution by any other than human agency. Finally Mr. Cook stated his belief that the cocoa palm had its origin in some of the valleys on the western slopes of the Andes and had travelled westward in company with man.

F. A. Lucas.

PHILOSOPHICAL SOCIETY OF WASHINGTON.

At the 528th meeting, held January 19th, Mr. L. A. Fischer read 'A Brief History of the Office of Standard Weights and Measures.' He said the office had grown up under the necessity of providing uniform standards of weight and measure for the custom houses. In 1836 copies of these standards were ordered to be furnished to the several States. In 1866 the office was directed to supply copies of metric standards, and still later it has been charged with verifying polariscopes and instruments for electrical measurements.

Mr. A. L. Day, now of the Geological Survey, gave an interesting account of the development, organization and work of 'The Physikalische-Technische Reichsanstalt' of Berlin, in which he was engaged for several years.

Mr. S. W. Stratton, by invitation, spoke on 'The Proposed Standardizing Bureau,' giving a résumé of the plans and of the means taken to bring the subject before Congress, and reading from printed reports some of the arguments made before committees.

Charles K. Wead,
Secretary.

THE LAS VEGAS SCIENCE CLUB.

THE second meeting of the Las Vegas Science Club was held January 8th. Mr. Frank Springer exhibited and commented upon some crinoids from the Burlington Limestone at Lake Valley, New Mexico. He also exhibited and discussed specimens of *Uintacrinus socialis*, Grinnell, which he had found beautifully preserved in the cretaceous of Western Kansas. He showed a number of plates to illustrate a memoir on this species, which will shortly be published in the *Memoirs* of the Museum of Comparative Zoology. The abundance and excellent preservation of the material had permitted him to determine many new facts regarding *Uintacrinus;* and after tabulating the characters of over 600 individuals it became evident that *U. socialis* of America and *U. westfalicus* of Europe were identical, the supposed specific distinctions being due to age and variation.

Mr. E. L. Hewett spoke on the ancient cliff-dwellings and communal buildings of the Pajarito district, New Mexico. He had for some years been engaged in the investigation of these, and presented a map showing their distribution, a number of plans and photographs, and a collection of objects obtained from the dwellings and burial mounds. The communal buildings of the Tchrega, Tsankiwi, Navakwee and Otow; mesas were described; the first of these was estimated to have contained nearly 1,500 rooms, being much larger than the buildings still in use at Taos. Mr. Hewett referred to the importance of preserving these ruins for systematic and careful examination, and the desirability of retaining as public property such important evidences regarding the early man of America as abounded throughout the district. To this end a bill is now pending in Congress, which provided for the retention of the district as a National Park.

T. D. A. C.

NEW YORK SECTION OF THE AMERICAN CHEMICAL SOCIETY.

A STATED meeting was held at the Chemists' Club, 108 West 55th Street, on January 11th, Dr. C. A. Doremus, presiding, and 53 members present.

Dr. Parker reported progress for the Committee appointed to confer with the Bureau of Combustibles in regard to the storage of acids.

The Chair reported that the revision of the By-Laws was in the hands of the Executive Committee in accordance with the action taken at the November meeting. A resolution offered by A. C. Hale was then read as follows:

Resolved, That the New York Section of the American Chemical Society herewith extends a most cordial invitation to the Society to celebrate the 25th anniversary of its foundation next April in New York City, and the Chairman of the New York Section is hereby authorized and directed to appoint such local committees as he may deem expedient in order to aid in perfecting arrangements for such celebration."

The resolution was unanimously approved and the Secretary was instructed to formally extend the invitation to the Society at large.

Dr. T. O'Connor Sloane then read his paper entitled, 'Notes on Spheroidal State Evaporation,' with experiments.

Dr. McMurtrie made a report on the Midwinter meeting just held in Chicago, to the effect that it had been very successful, and the visiting members were well entertained. One hundred and thirty-nine members were registered. Numerous applications for membership in the Society had been entered as a result of the interest aroused.

DURAND WOODMAN,
Secretary.

DISCUSSION AND CORRESPONDENCE.

NOTE ON VEGETO-ELECTRICITY.

IN SCIENCE, September 8, 1900, is an abstract of a paper, by Dr. Waller, on 'The Electrical Effects of Light upon Green Leaves,' which recalls an experience noted in 1888 in my physical laboratory work. In June of that year I asked a student to determine the magnetic elements at a certain place, just under the outer ends of the long branches of a low Norway maple. He reported that the magnetometer was in such continual tremor and slight shifting about that it was impossible to make accurate readings. This continued for hours; and was quite noticeable again some days subsequently

—so that the station was abandoned. This movement was not due to wind, nor to a magnetic storm, nor to any mechanical jarring of the earth.

Except an indefinite item in a newspaper, I have seen no mention of a similar experience.

To determine whether there is from trees such a discharge of electricity as might affect a delicate magnetic needle, I made (in 1895) a coil about 80 cm. diameter of fifty turns of wire, mounted on the end of a long pole, with a contact breaker and a telephone receiver in circuit, and had this coil held in such relation to large, dense limbs of trees as to enclose the lines of magnetic force from a discharge stream (if there be one) of electricity from the limb, selecting limbs in such direction as would make the coil when in proper relation lie in the magnetic meridian plane, determined by simple compass.

April 8th–12th, buds just swelling on deciduous trees, I tried a number of trees, including two or three evergreens. I could hear no disturbance in the telephone, in any position of the coil. Then putting the coil in the magnetic meridian, as explained above, to make the action (if any) stronger than mere variation of discharge, I had the circuit opened and closed. Still there was not the slightest effect perceptible. In the latter half of May, leaves quite fully developed on all except the various oaks, the experiments were repeated with the same negative results.

According to Dr. Waller's experiments, it would have been better to try my experiment in June (when the unexplained action was observed), rather than April and May, the leaves then being in fuller vigor and the temperature higher.

I. Thornton Osmond.

State College, Pa.,
January 21, 1901.

Scientific Expedition to Iceland, Greenland and Labrador.

A geological and geographical excursion in the North Atlantic is planned for the summer of 1901. Conditionally on the formation of a sufficiently large party, a steamer of about 1,000 tons, specially adapted for ice navigation, and capable of accommodating sixty men, will leave Boston on or about June 26th and return to the same point on or about September 20th. The main object of the voyage will be to offer to the members of the excursion party opportunity of studying the volcanic cones and lava-fields, the geysers, ice-caves and glaciers of Iceland, the fiords and glaciers of the west coast of Greenland, and the mountains and fiords of Northern Labrador. Some attention will be paid to the hydrographic conditions of the waters traversed. Botanists, zoologists, ornithologists, mineralogists and those interested in other branches of natural history may pursue independent studies. A hunting party may take part in the expedition; it could be landed for a fortnight or three weeks in Greenland and for about the same period in Labrador.

Explanatory lectures on the regions visited will be given from time to time by the leader of the excursion, who will also act as guide on the Labrador coast where he spent the summer of 1900. It is expected that in Greenland and Iceland, specialists on the geology and physical geography of these countries will lead the party. Wherever possible the attempt will be made to increase the stock of existing information concerning the three regions. It is desirable, though not necessary, that applicants for membership in the party possess at least an elementary knowledge of geology. Citizens of other countries as well as of the United States are invited to participate in the expedition. A physician will accompany the party.

An inclusive fee of $500 for each member will be charged, $250 to be deposited with the leader of the expedition on or before March 15th, the balance to be paid on or before June 1st.

The trip will be under the direction of the writer, and applications for membership should be addressed to him.

R. A. Daly,
Department of Geology and Geography, Harvard University.

Current Notes on Meteorology.

Report of the Chief of the Weather Bureau.

The 'Report of the Chief of the Weather Bureau for 1900' devotes considerable space to forecasts. The beginning of storm forecasts for

the North Atlantic Ocean is noted, this step being made possible by the use of reports now received from the West Indies, the Bahamas, Bermuda, France, Great Britain, Germany, etc. Whenever possible, forecasts are to be made of wind force and direction for the first three days of the voyage of all outgoing steamships. A brief history of each hurricane that occurred during the year is given, with copies of statements from persons not connected with the Weather Bureau regarding the efficiency of the storm-warning service. An important improvement in connection with the display of storm-warnings for the benefit of mariners has been made by the adoption of a specially constructed steel tower, with a flagpole at its summit. From this pole the signal flags are flown by day, and on it lanterns are displayed at night. 'Eminently satisfactory' progress is reported to have been made with experiments in wireless telegraphy. The importance of the Weather Bureau's Lake Marine service may be understood from the statement that 'each of the 20,000 or more vessels that pass Detroit receives the latest information available with regard to the force and direction of the wind, and the location and probable movement of storms.'

WEST INDIAN HURRICANES.

UNDER the title 'West Indian Hurricanes' the Weather Bureau has issued a report, prepared by Professor E. B. Garriott, which will find many interested readers. Since the United States has come to take an active political interest in West Indian affairs, West Indian hurricanes have assumed an additional importance in the eyes of the American people. This monograph gives a general account of these storms, their laws of circulation, cloud movements, tracks, formation, prognostics and characteristic phenomena. Poëy's table of hurricanes from 1493 to 1855 is given, supplemented by a table based on Weather Bureau records, giving the hurricanes from 1878 to 1900. Then follow brief descriptions, arranged by months, of recent hurricanes, including the famous 'Galveston Storm' of last September, and lastly local descriptions of historic hurricanes. Charts showing the hurricane tracks for each month for the years 1878 to 1900 accompany the report, which is to be recommended as being a readable, non-technical discussion of the subject with which it deals.

MONTHLY WEATHER REVIEW.

THE *Monthly Weather Review* for September (issued November 16th) contains the following articles: 'West Indian Hurricane of September 1–12, 1900,' by Professor E. B. Garriott; 'Special Report on the Galveston Hurricane of September 8, 1900,' by Dr. I. M. Cline, Local Forecast Official at Galveston; 'The Storm Waves of South Carolina and Texas,' by General E. P. Alexander; 'On the Color and Polarization of Blue Sky Light,' by N. E. Dorsey; 'Review of Professor Very's Memoir on Atmospheric Radiation,' by N. E. Dorsey; 'The Frequency of Hail in the United States' and 'The Crop as depending on Meteorological Conditions,' by Professor Cleveland Abbe.

R. DEC. WARD.

BOTANICAL NOTES.

BOTANICAL OPPORTUNITIES IN WASHINGTON.

IT may be doubted whether the botanists of this country fully realize the magnitude of the botanical work now being done in Washington. In the Department of Agriculture there are several 'divisions' devoted wholly to botanical investigations, and several others whose work contributes more or less to the enlargement of our scientific knowledge of plants. Thus the 'divisions' of Botany, Vegetable Physiology and Pathology, and Agrostology are so many divisions of the science of botany, while the 'divisions' of Forestry, Soils, Biological Survey, Experimental Gardens and Grounds, and Pomology, and the 'section' of Seed and Plant Introduction, are more or less contributory to botanical science. All these have much in them which is of interest to the botanist; in fact, some of the most interesting contributions to the scientific aspects of botanical inquiry have come from the second list, where the applications of science are generally emphasized. To these must be added the National Herbarium under control of the Smithsonian Institution, where are stored nearly a million botanical specimens.

With the liberal policy followed by the Secretary of Agriculture and the Regents of the Smithsonian Institution, there are here many opportunities for profitable work along different lines. In spite of the crowded quarters in which all the men in these 'divisions' are compelled to work, they are willing to make room for botanists who wish to study with them. With a little encouragement it is probable that a system of 'tables' will be arranged for the benefit of investigators who wish to take advantage of the collections, libraries, laboratories, and more than all—of the men to be found here. When we remember that there are from thirty-five to forty trained botanists in the government service, we can realize somewhat better what it may mean to most teachers of botany (generally isolated from their kind) when the opportunity is open to spend a couple of months in botanical study in Washington. So also with the lonely experiment-station botanist, puzzling over the problems that come to him, a few months of personal contact with these experienced workers in Washington would be of the greatest service. Without reflecting upon the work of the marine and other aquatic laboratories, it is safe to say that for most botanical teachers and experiment-station botanists a few weeks of study in the 'divisions' in Washington would be of more value.

In this connection it is well to emphasize the fact that the scientific 'divisions' in the Department of Agriculture should have more and better rooms for the trained men who are at work in them, as well as for the preservation of the collections, libraries and laboratories. Congress should not hesitate to grant the moderate sum asked by the Secretary of Agriculture for increased laboratory facilities. Eventually there should be a fire-proof building for the department, so planned that it may furnish adequate laboratory facilities for all the 'divisions,' and complete protection to the priceless collections of specimens and books, at the same time providing for the enlarged uses referred to above.

CENTRAL MASSACHUSETTS FORESTS.

In an interesting paper in *Rhodora* (Vol I., No. 8), Professor G. E. Stone discusses the forest conditions of central Massachusetts. In the course of his discussion he says: "The characteristic forest trees in this locality are the pine, chestnut, oak and birch. The pine and chestnut are especially adapted to this region, as is shown by their great abundance, both of these being more common in central Massachusetts than in any other portion of the State. The pine is especially abundant here, because of the fact that it can adapt itself to a great variety of conditions." A little later in his paper we find that "the principal forest trees at present are the pine, chestnut, oak, birch, maple, alder, poplar, willow, ironwood, hickory, hemlock, ash, cedar, spruce, beech. Their predominance follows quite closely after the order named. This order is not, however, the same as that which occurred in the primitive forests. The hemlock, beech and canoe birch have decreased, and other species have taken their places. The pine was always, and is to-day a valuable and prominent tree in this region, and undoubtedly is holding its own. The amount of young pines now in central Massachusetts is considerable. There is in fact no tree which takes so readily to the old and neglected pastures as does the pine, and they are gradually becoming filled with this species. This is a most fortunate occurrence, as these old pastures are practically worthless for other purposes, and it is by this means that the pine holds its own so readily, and compensates for that loss which occurs in consequence of rotation with hardwood where forests of this tree have been cleared." Professor Stone concludes from a study of the historical records of the forests that "on the whole, the climatic conditions have probably not changed very much, though undoubtedly local effects have been brought about by the removal of the forests, and also from industrial activities."

CHRYSANTHEMUM RUST.

Dr. J. C. Arthur, of the Indiana Experiment Station, has given the results (in Bulletin 85) of his experiments on the rust which affects the chrysanthemum. This is a true rust (*Uredineae*), and to it the name of *Puccinia chrysanthemi* has been given (1900) by Roze, a French botanist. It has been known in this country and Europe

for a few years only, but apparently it has been known for a long time in Japan. In order to settle the question whether the rusts affecting other Compositae might give rise to that on the chrysanthemum, Dr. Arthur made many cultures of the rusts on this and other related plants. He found that he could not infect other Compositae with the uredospores of chrysanthemum rust, nor could he infect chrysanthemum with the uredospores of the rusts of other Compositae. No teleutospores have yet been observed in this country or Europe, and this fact is likely to make the disease more easily controllable. Hand-picking the diseased leaves, and spraying with Bordeaux Mixture or sulphide of potassium are recommended.

CHARLES E. BESSEY.

THE UNIVERSITY OF NEBRASKA.

THE NATIONAL OBSERVATORY QUESTION.

THE introduction by Senator Morgan last week of a bill to organize the National Observatory of the United States, of which we have not yet seen a copy, and a letter from Professor Bigelow which we published last week, suggest a condensed statement of the points at issue. The grounds taken by SCIENCE are these:

1. The United States, like every other leading government of the world, should have a national astronomical observatory.

2. The special object of this observatory should be to make those observations and calculations on the courses of the stars which are useful in the world's progress, and require to be pursued with greater system and persistence than is possible in any but a national establishment.

3. This purpose requires that the observatory should have a well understood and well defined policy and plan of work, mapped out by the best scientific authorities at command of the nation and obligatory on the scientific staff.

4. No work but the best should be done; of second-class work an abundance may be had everywhere. This requires that the instruments should be of the best.

5. To attain these purposes it is necessary that the head of the observatory be an experienced astronomer. This because of the high technical skill and experience required in planning the work, in seeing that the innumerable details necessary to its excellence are attended to, and in so expending the funds of the observatory as to get the best results, and also to inspire the confidence of the scientific public in the high quality of the work.

Every effort on the part of our astronomers to get an observatory of this kind established has been defeated through the impression that we already have one which answers the purpose. In the opinion of every astronomer who has publicly expressed views on the subject this is not the case. So far as we are able to collect published views, while there may be much disagreement on side issues, there is absolute unanimity that the existing observatory fails to perform the required functions in a satisfactory way. Yet, we are quite ready to regard the question as an open one until everything that can be said in favor of the work and results of the existing observatory is brought out. If there is a single astronomer in the land who, after a careful examination of the published volumes of the observatory, draws the conclusion that the objects in question have been satisfactorily gained, or, after having read the annual reports of the past five years, concludes that they describe the class and character of work which should be expected from the most expensively supported astronomical observatory in the world, the columns of SCIENCE are cordially thrown open to him to make known his views, and the facts on which those views are based.

It is a well-known fact that our existing observatory is unique in the main feature of its

organization, that of being governed by a head who is not an astronomer and who has no thread of law to guide him in his administration. Another unique feature, without parallel in the history of astronomical observatories, is the misfortunes with its instruments which we pointed out in our first issue of this year. Here our information was based wholly on the official reports, no weight being given to the possibility that the actual condition of the instruments may be a little worse than made known in the public statement. Is it possible to dissociate in the mind of the scientific public these two unique features?

We commend the reading of what Mr. Bigelow has said on the subject, though he is silent on its main points, and the grounds he takes are not at all clear to us. On one point he labors under a misapprehension. If he will re-read our article he will see that we made no charge against the administration in connection with the Magnetic Observatory, but only inquired how it happened that one of the finest magnetic observatories in existence was set-up in the immediate neighborhood of a trolley line, the electric current of which would necessarily be destructive to the results. Mr. Bigelow informs us, as a 'well-known' fact, that this was done by the united counsel of the astronomical director and a prominent visiting English astronomer and against the arguments of the professor in charge of the work, and all others in Washington interested in magnetic observations. He intimates that other interests than those of science prompted the proceedings. We are thankful for this statement, which, if correct and complete, will enable the reader to draw his own conclusions, but we do not know on what ground he says that the fact is 'well known.' It may be well known to those concerned, or to people in Washington generally, but we never before heard or read of it. We may remind Mr. Bigelow that an unnamed 'visiting astronomer' cannot bear a heavy weight of responsibility, and we hope that he will allow this unfortunate counsellor to state his side of the case.

This summary of views, reasons and arguments, seems to exhaust the case in its present aspects, though we may need to return to it when Senator Morgan's bill and the naval appropriation bill are taken up by the Senate. The question is not of concern to astronomers only, but is probably the most important subject at present before American men of science.

SCIENTIFIC NOTES AND NEWS.

M. Fouqué, professor of mineralogy in the Collège de France, assumed the presidency of the Paris Academy of Sciences at the first meeting of the year on January 7th, succeeding M. Michel Lévy. M. Bouquet de la Grye was elected vice-president, and will consequently assume the presidency next year.

Dr. Grabowsky, of the Natural History Museum at Brunswick, has been appointed director of the Zoological Gardens at Breslau.

Mr. E. J. Butler, M.B., has been appointed by the Secretary of State for India, on the recommendation of the director of the Royal Gardens, Kew, to the post of official botanist to the Indian Government at a salary commencing at £600 per annum.

Mr. William Wallace has resigned the position of superintendent of the building of the American Museum of Natural History.

Terrestrial Magnetism reports that Mr. James B. Baylor has now completed the magnetic survey of North Carolina, which has been carried out at the joint expense of the U. S. Coast and Geodetic Survey and the North Carolina Geological Survey. The first report upon this work, prepared by Messrs. Baylor and Hazard, is ready for distribution.

The British Institution of Mechanical Engineers has presented the first Willan's premium to Captain H. Riall Sankey.

LORD RALEIGH has been appointed chairman of a Board of Trade committee to consider the extent to which the working of the traffic on the Central London Railway produces vibration in the adjacent buildings, and what alterations in the conditions of such working or in structure can be devised to remedy the same.

PROFESSOR MANSFIELD MERRIMAN, head of the department of civil engineering, Lehigh University, has issued a circular letter to the County Commissioners throughout the State of Pennsylvania, offering on behalf of the University, to make, without expense to the Commissioners, tests of hydraulic cement to be used on public works. In the report of the results of these tests no opinion will be expressed on the value of the cements.

AT the annual meeting of the Washington Academy of Sciences, on January 17, 1901, the following officers were elected:

Chas. D. Walcott, *President.*

W. H. Holmes, *Vice-President* for the Anthropological Society.

F. A. Lucas, *Vice-President* for the Biological Society.

V. K. Chestnut, *Vice-President* for the Chemical Society.

John A. Kasson, *Vice-President* for the Columbia Historical Society.

H. G. Dyar, *Vice-President* for the Entomological Society.

A. G. Bell, *Vice-President* for the Geographic Society.

G. K. Gilbert, *Vice-President* for the Geological Society.

S. C. Busey, *Vice-President* for the Medical Society.

J. Howard Gore, *Vice-President* for the Philosophical Society.

Frank Baker, *Secretary.*

Bernard R. Green, *Treasurer.*

Managers: Class 1902—L. O. Howard, J. W. Powell, Carroll D. Wright. Class 1903—F. W. Clarke, C. Hart Merriam, Whitman Cross. Class 1904—Marcus Baker, Geo. M. Sternberg, G. M. Kober.

THE Middleton Goldsmith Lecture for 1901, before the New York Pathological Society, will be delivered by Dr. Charles S. Minot on March 26th. The subject announced is 'The Embryological Basis of Pathology.' We learn that it is the lecturer's intention to discuss the general laws governing both the normal and pathological differentiation of cells.

THE Duke of the Abruzzi and Captain Cagni gave before the Italian Geographical Society, on January 14th, accounts of their recent Polar expedition. The King and Queen of Italy and a distinguished audience were present. The freedom of the City of Rome has been conferred on the Duke of the Abruzzi.

PROFESSOR FRANCIS H. HERRICK, of Western Reserve University, delivered an illustrated lecture before the Sigma Xi Society of Yale University on January 19th, on 'The Habits of Wild Birds.'

THE annual meeting of the Neurological Society of London was held on January 24th, when the presidential address was delivered by Dr. W. J. Mickle on 'Mental Wandering.'

PROFESSOR SILVANUS P. THOMPSON gave a lecture on January 10th, at the Urania, in Berlin, on 'Faraday and the English School of Electricians.'

THE Royal Geographical Society of Australasia has established a Thomson Foundation Medal in recognition of Mr. J. P. Thomson's great services to the Society, of which he is regarded as the founder, and which he has served in many capacities. The gold medal is to be awarded annually for the best original contribution to geographical literature, preference being given to the geography of Australasia.

THE annual meeting of the Geographical Association was held in London on January 9th, when Mr. Douglas W. Freshman was elected president and Mr. A. J. Herbertson, vice-president. The membership of the Association is now 134, representing 84 schools and colleges. Plans are being considered for the publication of a geographical journal for teachers of geography.

THE annual meeting of the Board of Regents of the Smithsonian Institution was held on January 23d. The following changes were announced in the membership of the Board: Hon. Richard Olney, to succeed Dr. William Preston Johnston, and Judge Gray of Delaware, to fill the vacancy caused by the death of Dr. William L. Wilson. The vacancy in the executive committee, caused by the death of Dr. Wilson, was filled by the election of Representative

Hitt of Illinois. It was decided in view of the proposed abolition of the English cemetery at Genoa which contains the remains of James Smithson, the founder of the Institution, that the Secretary be requested to arrange with the authorities of some other cemetery, at Genoa, for the re-interment of Mr. Smithson's remains and the transfer of the original monument. It will be remembered that the Smithsonian Institution placed a tablet on Smithson's tomb and that it is properly cared for.

At a meeting held recently at Colchester it was decided to erect a marble statue of William Gilbert, whose great work, *De Magnete*, published just three hundred years ago, laid the foundation of electrical science. The statue, towards which £130 has been subscribed, is to occupy a niche in the façade of the new town hall of Colchester.

We regret to learn of the death, at the age of sixty-six years, of Elisha Gray, which occurred on January 21st, from heart disease. Mr. Gray was the author of 'Experimental Researches in Electroharmonic Telegraphy and Telephony' and of 'Elementary Talks on Science,' and is well-known for his important inventions in telegraphy, telephony and electrical appliances.

Colonel F. F. Hilder, chief clerk of the Bureau of American Ethnology, died of pneumonia at his home in Washington on January 21st, at the age of seventy-four years.

The death is announced, at the age of thirty-eight years, of Mr. John Henry Leech, the English entomologist. He was the author of numerous works on this science including 'The Butterflies of China, Japan and Corea.' The collections made by him for this work are now partly in the South Kensington Natural History Museum. Mr. Leech was proprietor of *The Entomologist*.

We also regret to learn from *Nature* that Mr. S. W. Egan, since 1868 connected with the Geological Survey of Ireland, died in Dublin on January 6th; and that Dr. Giulio Pacher, docent in experimental physics in the University of Padua, has died at the age of thirty-three years.

The will of Oswald Ottendorfer sets aside about $200,000 for public bequests, including $25,000 to the American Museum of Natural History, $20,000 to the Cooper Union for the advancement of science and art, and $20,000 to the New York Free Circulating Library.

Through the liberality of T. M. Baird, Jr., Esq., of Victoria, B. C., a tract of land on the coast of Vancouver Island, opposite Cape Flattery, has been presented for a seaside botanical station of the University of Minnesota. The erection of a group of log buildings has been begun, and a party of thirty or more botanists has been organized to open the work of the station next June.

Half the educational staff of the Royal Engineering College at Coopers Hill has been summarily dismissed, for the purpose, as it is somewhat oddly stated, of 'reducing the present excessive cost of the staff and increasing the efficiency of the teaching.' The College at Coopers Hill is primarily for the training of students for the public works—telegraphs, railways, etc.—of India, and appears to be under the direction of a military officer with no scientific or educational qualifications and a board of visitors. There is a general protest against this action, Lord Kelvin, for example, having written to the London *Times* as follows:

> The correspondence which appeared in the *Times* of Januard 3d regarding Coopers Hill College has caused a painful shock to all who know of the good work which the college has done in giving to India the benefits of well-trained engineers in the service of its Government. No one can read that correspondence, I believe, without being convinced that the seven professors and teachers whose position is threatened are justified in asking for an inquiry.
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> The proposed action—a sudden and arbitrary dismissal of able and distinguished scientific teachers who have been doing duty for periods of from nine to thirty years in a satisfactory manner—is certainly not to be expected in institutions under the control of the British Government; and I sincerely hope that the Secretary of State for India in Council will see his way to granting the request for an inquiry.

Another case, in which the appointment of a military officer without scientific attainments as head of a scientific institution has worked unfortunately, is brought to our attention in the case of M. Charles Lagrange, director of the Royal Observatory of Belgium. It appears from the *Independence Belge*, as quoted in *Na-*

ture, that M. Lagrange has resigned his office and has presented to the Belgian Academy of Sciences his two years' arrears of salary, or a capital sum of ten thousand francs, to establish a prize to be awarded, at intervals of four years, for the best contribution to our knowledge of the physics of the globe. In expressing the thanks of the Academy for the gift, General Brialmont described the circumstances which led to M. Lagrange's resignation. It appears that for the past two years the position of director of the Observatory has been a humiliating one, because a young infantry officer, without scientific attainments, has controlled the establishment.

WE are glad to notice that the House of Representatives has, under a suspension of the rules, passed a bill increasing the salary of the Commissioner of Education for Porto Rico from $3,000 to $4,000. If, however, our Government is generous in disposing of the money of the Porto Ricans, it should be just in distributing the greater wealth at its disposal, and the eminent Commissioner of Education for the United States should receive as large a salary as the commissioner for Porto Rico.

MR. STARK has introduced into the House of Representatives a resolution of the Legislature of the State of Nebraska, requesting the passage of the bill for the establishment and maintenance of a school of mines in every State where such does not now exist, which has been referred to the Committee on Public Lands.

AT a recent meeting of the New England Anti-vivisection Society, Joseph L. Greene quoted from Senator Gallinger, of New Hampshire, to the effect that the bill against cruelty to animals in the district of Columbia would probably not be taken up at the present session, because of the pressure of business.

THE German budget for 1901 includes 200,000 Marks for the construction of a laboratory for hydraulic experiments at Berlin. The total cost of the laboratory will be about 365,000 Marks. It will be used by the administrations of the Imperial Marine and Inland Waterways and by the students of the technical school. The budget also provides for non-recurring expenditures on science and art over 6,000,000 Marks.

GREAT interest is being taken in the imminent drying up of Great Salt Lake caused by irrigation. We are informed that the plan suggested by Mr. Marcus E. Jones to build a canal from the headwaters of the Snake river, and thus bring water into the Great Basin to replace the waste by evaporation is meeting with general favor. The Utah Legislature is expected to take up the matter at this session. The agricultural sections of Utah are threatened with disaster unless something is done soon.

UNDER the auspices of the International Aëronautical Committee balloon ascents for meteorological purposes were made on January 10th—in so far as the program was carried out—at London, Bath, Paris, Strasburg, Berlin, St. Petersburg and in Virginia.

WE learn from the *Electrical World* that, at a recent meeting of the Frankfort-on-the-Main Association of Electrical Engineers, Herr Wolff, manager of the local branch of the Allgemeine Elektricitäts-Gesellschaft, showed a new form of Nernst lamp. The necessary initial heating of this lamp is effected by a spiral of platinum embedded in fireproof composition. By means of a switch concealed within the base of the lamp, this spiral is automatically cut out of circuit after the lamp has been rendered sufficiently conductive by the imparted heat.

UNIVERSITY AND EDUCATIONAL NEWS.

YALE UNIVERSITY has received a bequest of $50,000 by the will of Albert E. Kent of Chicago, a graduate in 1853. The money is to be used for the enlargement of the Kent Chemical Laboratory which Mr. Kent gave to the University twenty years ago. Yale University has also received during the week, by the death of Benjamin Douglas Silliman, the oldest alumnus of the University, a sum, said to be $80,000, left by a brother in trust. It is expected that the University will also receive a bequest by the will of Mr. Silliman. Yale University would also receive a trust fund of $500,000, left by T. B. Winthrop, an alumnus, in case neither of his children should survive.

Mr. John D. Rockefeller has offered to give $200,000 to Oberlin College, on condition that $300,000 in addition be collected during the year.

The sum of $25,000 has been collected for Amherst College, making available $75,000 promised by two alumni, Mr. D. Willis James and Mr. C. M. Platt.

Mr. H. H. Hunnewell, of Wellesley, has given $25,000 to Wellesley College for the department of botany.

The will of the late Joseph Ricker, of Portland, Maine, provides for the distribution of about $300,000 among charitable, religious and educational societies. Among the bequests are the following: Bowdoin College, $20,000; Bangor Theological Seminary, $25,000; Tuskegee Institute, $2,500, and Bates College, $10,000.

On January 1, 1901, President Jas. W. Strong had secured gifts and pledges to the endowment fund of Carleton College amounting to $100,000. This secured the conditional gift of $50,000 from Dr. D. K. Pearsons offered a year ago. The college has always given unusual prominence to its scientific courses and has an exceptionally good equipment of scientific apparatus.

A university for women has been founded in Tokio and is expected to open in 1901. A site and about $120,000 have been donated to it.

There will be a second meeting of the Association of Universities in Chicago from February 26th to 28th. Among the snbjects to be discussed are 'Migration among Graduate Students,' 'Examinations for the Doctor's Degree,' 'Fellowships' and 'To what extent should a Candidate for the Doctor's Degree be required to show a Knowledge of Subjects not immediately connected with his Major Subject?'

The University of California will offer at its next summer session instruction in philosophy, education, history, Latin, Greek, physics, chemistry, botany, mathematics and other departments. A short course for farmers is being planned, in which practical instruction will be given in horticulture, irrigation, dairy husbandry, stock breeding, etc. The following professors from eastern universities will take part in the work: James E. Russell, dean of the Teachers College of Columbia University; John Dewey, professor of philosophy in the University of Chicago; H. Morse Stephens, professor of modern history in Cornell University; James W. Bright, professor of English philology in Johns Hopkins University; Liberty Hyde Bailey, professor of horticulture in Cornell University; and Albert S. Cooke, professor of the English language in Yale University.

C. E. Chadsey, Ph.D. (Columbia), has been appointed lecturer in the department of education, University of Colorado. He will lecture on sociological topics, etc. P. H. Keyser, M.D., has been appointed instructor in psychopathology in the department of psychology of the same university. Students in the law school are required to take the course, and it is an elective in the medical school.

Dr. Wm. G. Spiller has been appointed demonstrator of neuropathology at the University of Pennsylvania, and will conduct an elective course for a limited number of graduates and students for the study of the pathology of the central nervous system and the preparation and examination of microscopic sections.

John M. Bucher, Ph.D. (Johns Hopkins), has been appointed associate professor of chemistry at Brown University. He recently graduated at Lehigh University and has been instructor in Tufts College. At the same university Mr. W. B. Jacobs has been appointed professor of the science and art of teaching.

Joseph S. Chamberlain, Ph.D. (Johns Hopkins), instructor in chemistry, Oberlin College, has accepted the position of private assistant to Professor Ira Remsen, Johns Hopkins University.

Dr. Max Verworn, associate professor and assistant in the Physiological Institute in the University at Jena, has been called to an associate professorship of physiology at Göttingen, where he will be director of the Physiological Institute.

Dr. H. Goldschmidt, associate professor of chemistry at Heidelberg, has been called to the University of Christiania.